CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION
3443 Routier Road, Suite A, Sacramento, California 95827

**NOTICE OF PUBLIC HEARING**
and
**NOTICE OF FILING OF DRAFT ENVIRONMENTAL DOCUMENTS**
concerning
**AMENDING THE WATER QUALITY CONTROL PLAN FOR THE CONTROL OF MERCURY IN CLEAR LAKE , LAKE COUNTY**

The Regional Water Quality Control Board, Central Valley Region (Regional Board) will hold a public hearing to consider adoption of the proposed amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) to establish water quality objectives for methylmercury and to establish an implementation plan to reduce the concentration of mercury in fish, water, and sediments of Clear Lake. As part of amending the Basin Plan, the Regional Board will consider certification of the draft "functionally equivalent" environmental documents prepared pursuant to Section 21080.5 of the Public Resources Code and Title 23 California Code of Regulations sections 3775-3782. The public hearing will be part of a regular meeting of the Regional Board at the time and location noted below:

Date: September 6, 2002
Time: 9:00 a.m.
Place: City of Redding Council Chambers
777 Cypress Avenue
Redding, CA 96001

On May 22, 2002, the Regional Board staff conducted a workshop to receive comments from the public on issues that should be considered in amending the Basin Plan. Based on comments received in writing and at the workshop, staff has prepared a report that summarizes the issues identified and presents staff recommendations.

Staff is proposing for Regional Board consideration a site specific methylmercury objective for Clear Lake in Lake County. The proposed objective consists of a methylmercury concentration in fish tissue. To achieve the methylmercury objective, staff is proposing an implementation plan to reduce mercury loads to Clear Lake. The objective and implementation plan apply only to Clear Lake. Draft environmental documents have been prepared for the proposed amendments which conclude that the proposals will have no significant adverse impacts on the environment .

The draft staff report for the proposed amendments, which includes the environmental documentation required under CEQA, may be obtained by contacting Patrick Morris at (916) 255-3121 or morrisp@rb5s.swrcb.ca.gov. The draft staff reports are also available for downloading at http://www.swrcb.ca.gov/rwqcb5/available_documents/ under the heading **Basin Plans.**

In order to be included in the written response to comments that is a part of the final administrative record, written comments should be submitted by **August 22, 2002** to Patrick Morris, Regional Water Quality Control Board, Central Valley Region, 3443 Routier Road, Suite A, Sacramento, CA 95827. At the hearing on September 6, 2002, staff will summarize the written comments and present a final recommendation for Regional

Board consideration. Interested persons will be provided the opportunity to present oral comments to the Regional Board at the hearing.

The hearing facilities will be accessible to persons with disabilities. Individuals requiring special accommodations are requested to contact Ms. Janice Tanaka at (916) 255-3039 at least 5 working days prior to the meeting. TTY users may contact the California Relay Service at 1-800-735-2929 or voice line at 1-800-735-2922.

Please bring the above information to the attention of anyone you know who would be interested in this matter.

KENNETH D. LANDAU, Assistant Executive Officer

10 July 2002

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

# AMENDMENT TO THE WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER BASINS FOR THE CONTROL OF MERCURY IN CLEAR LAKE (LAKE COUNTY)

## STAFF REPORT AND FUNCTIONALLY EQUIVALENT DOCUMENT

***Draft Report***
***July 2002***

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*DISCLAIMER*

*This publication is a technical report by staff of the California Regional Water Quality Control Board, Central Valley Region. No policy or regulation is either expressed or intended.*

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

# AMENDMENT
# TO
# THE WATER QUALITY CONTROL PLAN
# FOR THE SACRAMENTO RIVER AND
# SAN JOAQUIN RIVER BASINS
# FOR
# THE CONTROL OF MERCURY IN
# CLEAR LAKE (LAKE COUNTY)

## STAFF REPORT
## AND
## FUNCTIONALLY EQUIVALENT DOCUMENT

***Draft Report***
***July 2002***

**REPORT PREPARED BY:**

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# EXECUTIVE SUMMARY

This Central Valley Regional Water Quality Control Board staff report describes a proposal to amend to the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins to address the regulation of mercury in Clear Lake in Lake County. Regional Water Board staff will circulate this staff report and enclosed draft Basin Plan amendment for public review and comment prior to Regional Water Board consideration. Appendix F provides the recommended format for comment submittal.

Major components of the proposed amendment are:

- Addition of a beneficial use designation of commercial and/or sport fishing (COMM) for Clear Lake;
- Numeric objectives for methylmercury in fish tissue that are site-specific to Clear Lake;
- An implementation plan for controlling mercury loads; and
- A surveillance and monitoring program.

Clear Lake was added to the Clean Water Act 303(d) List of Impaired Waterbodies in 1988. The listing was based upon high levels of mercury in fish tissue and the existence of a fish consumption advisory, issued by the California Department of Health Services. The goal of this proposed Basin Plan amendment is to lower mercury levels in Clear Lake so that the beneficial uses of fishing and wildlife habitat are attained. The proposed Basin Plan amendment and alternatives considered are described below.

### Proposed Modifications to Basin Plan Chapter II (Existing and Potential Beneficial Uses)

Staff proposes addition of the commercial and sport fishing (COMM) beneficial use for Clear Lake. Clear Lake supports significant sport fishing and a small commercial fishery.

### Proposed Modifications to Basin Plan Chapter III (Water Quality Objectives)

Staff proposes site-specific, numeric objectives for Clear Lake. Methylmercury is the most toxic form of mercury and accumulates to the greatest extent in successive levels of the food chain. Methylmercury is a neurotoxicant that adversely affects reproductive and immune systems in humans and wildlife that consume fish. Nearly all methylmercury is obtained by humans and wildlife through consumption of mercury contaminated fish and shellfish. Because of these factors, staff proposes to express the numeric objective as a fish tissue objective for methylmercury rather than the more common water column objective. The alternatives considered for the numeric objective are based on consumption rates of contaminated fish; higher consumption rates correlate to lower numeric objectives. Staff considered five alternatives for the methylmercury numeric objective for Clear Lake:

1. **No Action -** Continued application of the Basin Plan's narrative objective for toxicity. This alternative does not set a numeric limit for the concentration of methylmercury in fish tissue.
2. **USEPA's recommended water quality criterion for the protection of human health, 0.3 mg methylmercury/kg fish tissue, wet weight**. The U.S. Environmental Protection

Agency (USEPA) recommended criterion assumes a fish consumption rate by humans of 17.5 g/day of locally-caught fish.

3. **Objectives of 0.13 and 0.30 mg/kg for fish in trophic levels 3 and 4, respectively**. The basic methodology used to derive the USEPA recommended criterion was adjusted using site-specific information regarding fish caught in Clear Lake. These objectives also assumed a fish consumption rate by humans of 17.5 g/day of locally caught fish. Trophic level 4 fish include largemouth bass and catfish. Trophic level 3 fish include hitch and bluegill.
4. **Objectives of 0.09 and 0.19 mg/kg for fish in trophic levels 3 and 4, respectively**. These levels were recommended by U.S. Fish and Wildlife Service to protect wildlife at Clear Lake. They allow adult humans to safely consume about 30 g/day of Clear Lake fish. The ninetieth percentile consumption rate reported in 1992 by a small group of residents, primarily members of the Elem Pomo Tribe, is 30g/day of Clear Lake fish.
5. **Objectives of 0.008 and 0.02 mg/kg for fish in trophic levels 3 and 4, respectively**. These objectives were developed using a consumption rate of 907 g/day (2 pounds/day), which is the estimated, traditional rate of consumption by Native Americans at the lake.

Staff recommends adoption of Alternative 4 (0.09 and 0.19 mg/kg in fish in trophic levels 3 and 4, respectively), which are numeric objectives based on protection of wildlife and human health. These objectives will protect existing and the proposed beneficial uses and improve water quality conditions. Attainment of the objectives is expected to improve the economy of the Clear Lake basin through improvements of the fishery.

## Proposed Modifications to Basin Plan Chapter IV (Implementation)

Staff proposes addition of a strategy to reduce mercury loads to Clear Lake, including load allocations and sediment compliance goals. The following sections describe the mercury source analysis, load reductions, and implementation alternatives to achieve the water quality objectives.

### *Source Analysis*

Clear Lake lies within a region naturally enriched in mercury. The large Sulphur Bank Mercury Mine (SBMM) on the shore of the lake and several smaller mines in the Clear Lake watershed are inactive. The Bradley Mining Company currently owns SBMM. The U.S. Environmental Protection Agency (USEPA) declared the SBMM a federal Superfund site in 1991. Since then, USEPA has completed several remediation projects, including regrading and vegetation of mine waste piles along the shoreline and construction of a diversion system for surface water runoff. The USEPA is currently conducting a remedial investigation to fully characterize the SBMM site in order to propose final remedies.

Staff estimated inorganic mercury loads entering Clear Lake for the following sources: ongoing inputs through groundwater, surface water, and flux to the air from the SBMM site; tributaries and other surface water that flow directly into the lake; and atmospheric deposition. Also identified as a source is mercury deposited historically in the lake due to mine operations or erosion at SBMM that contributes to mercury concentrations in fish today. There is considerable uncertainty in the estimated loads from SBMM; therefore, staff used the maximum estimated load as a basis for load reductions. As USEPA collects additional data, the load estimates will be refined through regular reviews of the Basin Plan mercury strategy.

Staff estimated inorganic mercury loads leaving Clear Lake for the following outputs: flux to the atmosphere from the lake surface; Cache Creek downstream flow; and burial in sediment. The lakebed sediment consists of an active surficial layer, in which mixing, resuspension, deposition, and chemical cycling occur. Surficial sediment is also the primary site of bacterial activity that transforms inorganic mercury into methylmercury. Below the active layer, mercury becomes buried and removed from the cycle. The implementation plan proposed as part of the Basin Plan amendment focuses on removing mercury from the surficial layer of lakebed sediment.

*Linkage Analysis and Load Allocations*

Levels of methylmercury in fish are assumed to be directly proportional to the concentration of mercury in surficial sediment. To meet the recommended water quality objectives, existing fish tissue concentrations would have to be reduced by 60%. A 10% margin of safety is added to account for uncertainties in the linkage analysis. Therefore, to meet the objectives, concentrations of mercury in surficial sediment must be reduced by 70% from existing levels. The proposed changes to the Implementation chapter include sediment compliance goals set at 70% of existing surficial concentrations of mercury for particular sites within each arm of the lake.

To reduce surficial sediment concentrations of mercury by 70%, mercury loads must be reduced by 70% as well. The acceptable sediment levels will be met by the following reductions in existing loads:

1. **Atmospheric Deposition.** Atmospheric deposition from the global pool of mercury is assumed to remain constant under water quality control provisions of this strategy. Therefore, the allocation is set at the load estimated to deposit on the lake surface from the global pool, 2 kg/year.
2. **Tributary Inputs.** Mercury loads from the tributaries and direct surface water runoff into the lake should be reduced to 80% of existing inputs. These inputs vary with water flow. In an average water year, the estimated load and load allocation are 18 kg/year and 14.4 kg/year, respectively. The load allocation is applied to the tributary inputs as a whole. Efforts to meet the allocation should focus on identifying and remediating hot spots of mercury loading within the tributary watersheds. On average, sediments coming from the tributaries contain lower concentrations of mercury than lakebed sediments.
3. **Sulphur Bank Mercury Mine.** The remainder of load reductions will come from reducing inputs from existing discharges and historical deposits from SBMM. The load allocation to the terrestrial mine site is 5% of ongoing loads. The load allocation to the active sediment layer in Clear Lake is 30% of existing sediment concentrations. Implementation alternatives requiring to achieve the load allocations from SBMM and lake sediments are presented below. Because mercury in groundwater is preferentially methylated, mercury transported in groundwater through the SBMM shoreline waste rock pile is limited to 0.5 kg/year. The load allocations are assigned to the owners of SBMM. Because SBMM is a Superfund site,

Region Board staff requests that the USEPA continue its investigations and conduct remediation activities to achieve the proposed reductions.

*Implementation Alternatives*

Staff considered five alternatives for the Regional Water Board's implementation plan for achieving the sediment compliance goals and mercury fish tissue objectives. All of the implementation alternatives will require public outreach regarding the levels of safe fish consumption and monitoring to assess progress toward the objectives. The first is the "No Action" alternative, under which no active remediation would be required. The other four alternatives differ by levels of remediation required at SBMM.

For Alternatives 2 through 5, the load reduction from the tributaries is a 20% reduction from existing mercury loads. Staff proposes requiring that the U.S. Bureau of Land Management, U.S. Forest Service, other landowning agencies in the Clear Lake Basin, and Lake County submit plans for monitoring and implementation to achieve the necessary load reductions. Staff will coordinate with the above named agencies and other interested parties to develop the monitoring and implementation plans. If significant sources are identified, Regional Water Board staff will coordinate with the agencies to develop and implement load reduction programs.

As noted above, the sediment mercury concentrations must be reduced by 70%. The various alternatives that staff considered (other than the "No Action") are all designed to meet the 70% reduction; the differences between the alternatives is the amount of active remediation required at SBMM and lakebed sediment and the corresponding length of time required to meet the 70% reduction. Allowing for turnover in the fish population, fish tissue objectives are estimated to be reached about 10 years after sediment concentrations have equilibrated. The USEPA is preparing a feasibility study and cost estimations for remediation of the SBMM site. Costs of the implementation alternatives are estimated from cleanup efforts elsewhere.

The five implementation alternatives are:

1. **No Action - Passive Burial of Sediments Contaminated with Mercury**. This alternative relies completely on passive burial of existing sediments under cleaner, incoming sediment to decrease concentrations of mercury in surficial sediment. Deep sediment cores depict a decline in mercury concentrations in some areas since SBMM closed. Assuming that the declines occur across the lake and continue as in the past, the sediment compliance goals for Upper and Lower Arms could be achieved in about 80 years and the goals in the highly contaminated, east end of Oaks Arm in 1,200 years or less. Major uncertainties remain about whether these assumptions are valid.
2. **70% Reduction of Past and Present Inputs from SBMM Combined with Natural Sedimentation**. Total mercury loads from SBMM, including any ongoing contributions from highly contaminated sediments near the mine site, must be reduced by 70%. Remediation activities on the terrestrial mine site will likely need to include: control and possible treatment of surface water runoff; control of groundwater flow into Clear Lake; and capping of waste rock. Meeting the load reductions will also require eliminating contributions to the surficial sediment layer of mercury previously deposited due to mine-related processes. Options to

remove the mercury in the lakebed that is being remobilized may include dredging the contaminated sediment, capping with clean sediments, facilitating natural burial of highly contaminated sediments, or reducing the transport of highly contaminated sediments from the Oaks Arm into the rest of the lake. Improvements in mercury levels in sediment of Upper and Lower Arms would largely depend on passive sedimentation.

The sediment goals in Oaks Arm could be reached in about 50 years. The most significant improvements across the lake would be expected in the first 25 years. The terrestrial mine site cleanup could cost $30-45 million. Total costs could be $50-230 million including tributary remediation projects, public outreach, and monitoring. Most of the additional cost and the broad range depends upon costs of remediating and/or ensuring burial of the highly contaminated lakebed sediments.

3. **95% Reduction of Past and Present Inputs from SBMM and Removal of All Contaminated Sediment in Clear Lake**. Total mercury loads from SBMM, including any ongoing contributions from highly contaminated sediments near the mine site, must be reduced by 95%. Mercury concentrations in surficial sediment in the entire lakebed would be reduced by 95% by removing contaminated sediment, ensuring burial, or another abatement option. Fish tissue objectives would be expected to be achieved in 25 years after implementation. This alternative would be very expensive, up to several trillion dollars to dredge sediment in the entire lake. Significant environmental impacts would likely occur due to disturbing most of the lakebed.

4. **95% Reduction of Present Inputs from SBMM, Removal of Some Highly Contaminated Sediment and Natural Sedimentation.** This is similar to Alternative 2, except that ongoing inputs from the terrestrial mine site would be reduced by 95%. Contributions from the highly contaminated sediments near SBMM would be reduced by 70%, with active remediation and the greatest level of improvements occurring within 15 years. Mercury concentrations in other parts of the lakebed would decline through natural sedimentation. Because inputs are substantially reduced, the sediment goals and fish tissue objectives would presumably be reached more quickly than in Alternative 2 (i.e., less than 80 years for Upper and Lower Arms), but the degree of difference is uncertain. Remediation costs at the terrestrial mine site would be $40-55 million, with sediment reductions costing $20-230 million.

5. **95% Reduction of Present Inputs from SBMM, Removal of Most of the Highly Contaminated Sediment and Natural Sedimentation.** The alternative requires that ongoing inputs from the terrestrial mine site to be reduced by 95%. Contributions from the highly contaminated, mine-related sediments near the mine site must also be reduced by 95%. The mine remediation should be completed in 15 years. Mercury concentrations in the remainder of the lakebed would decline through natural sedimentation. Regional Water Board staff estimates that reducing the highly contaminated sediments by 95% instead of 70% (Alternative 4) could cost an additional $10-80 million dollars, depending upon the type of sediment remediation used.

Regional Water Board staff recommends Alternative 4 for adoption into the Basin Plan. Alternative 4 provides the best balance between achievement of the fish tissue objectives within a timely fashion and cost. Under Alternative 4, sediment goals are expected to be reached in less than 80 years and fish tissue objectives within 10 years thereafter. This is a reasonable timeframe, given the extent of mercury pollution throughout the lake, the complexity of mercury fate and transport, and the period over which anthropogenic activities have impacted mercury levels in the lake.

Under Alternative 1, no remediation of ongoing sources of mercury would be implemented. Therefore, adoption of Alternative 1 is not expected to meet objectives nor provide protection of beneficial uses. Alternatives 2 may also not result in attainment of the fish tissue objectives because 30% of the loads from SBMM would still enter the lake. Alternative 3 would be extremely costly and could significantly impair the environment. Alternative 5 may cause unnecessary expense in remediation of nearly all of the highly contaminated sediments in Oaks Arm. The actions under Alternative 4 to eliminate inputs from 70% of the highly contaminated material (removal or ensuring burial) should allow sediment concentrations in the east end of Oaks Arm to be reduced further by natural sedimentation at no extra cost.

## Proposed Modifications to Basin Plan Chapter V *(*Surveillance and Monitoring)

Staff proposes a surveillance and monitoring program to ensure compliance with the objectives in Clear Lake. The program includes water, sediment, and fish tissue monitoring.

## Environmental Analysis

To satisfy requirements of the California Environmental Quality Act, staff performed an environmental analysis of the potential impacts of the proposed Basin Plan amendment, including beneficial use addition, numeric water quality objectives, and implementation plan. The proposed amendment was found to have no significant adverse effects on the environment.

**AMENDMENT TO THE WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER BASINS FOR THE CONTROL OF MERCURY IN CLEAR LAKE (LAKE COUNTY)**

**Staff Report & Functionally Equivalent Document**

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| | |
|---|---|
| 303(d) List | Clean Water Act 303(d) List of Impaired Waterbodies |
| ATSDR | U.S. Agency for Toxic Substances and Disease Registry |
| BAF | bioaccumulation factor |
| Basin Plans | Water Quality Control Plans |
| BCF | bioconcentration factor |
| bwt | body weight |
| CDFG | California Department of Fish and Game |
| CDHS | California Department of Health Services |
| CEQA | California Environmental Quality Act |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act (authorizes and provides guidance for the federal Hazardous Substances Superfund) |
| CTR | California Toxics Rule |
| CWA | federal Clean Water Act |
| GLWQI | Great Lakes Water Quality Initiative Final Rule |
| Hg | Mercury |
| LOAEL | lowest-observable adverse effect level |
| MRC | Mercury Study Report to Congress |
| MRL | ATSDR Minimal Risk Level |
| N | population size |
| NAS | National Academy of Sciences |
| NEPA | National Environmental Policy Act |
| NOAEL | no-observable adverse effect level |
| NRC | National Research Council |
| OEHHA | Office of Environmental Health Hazard Assessment |
| Regional Water Board | Central Valley Regional Water Quality Control Board |
| RfD | reference dose |
| SBMM | Sulphur Bank Mercury Mine |
| SDCDHS | San Diego County Department of Health Services |
| State Water Board | State Water Resources Control Board |
| Target Report | Clear Lake Mercury TMDL Numeric Target Report |
| TL3 | trophic level 3 |
| TL4 | trophic level 4 |
| TMDL | Total Maximum Daily Load |
| TMDL Report | Clear Lake Mercury TMDL Report |
| UC Davis | University of California-Davis |
| UC Davis CLERC | University of California, Davis Clear Lake Environmental Research Center |
| USDA | U.S. Department of Agriculture |
| USEPA | U.S. Environmental Protection Agency |
| USFDA | U.S. Food and Drug Administration |
| USFWS | U.S. Fish and Wildlife Service |
| WHO | World Health Organization |
| WRD | Waste Rock Dam (waste rock pile on the SBMM site) |

# 1 INTRODUCTION AND BACKGROUND

This Central Valley Regional Water Quality Control Board staff report (staff report) addresses a proposed amendment to the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins (CVRWQCB, 1998). The amendment addresses regulation of mercury in Clear Lake in Lake County.

The preparation and adoption of a Basin Plan is required by California Water Code Section 13240. The Regional Water Board Quality Control Board, Central Valley Region (Regional Water Board) initially adopted a Basin Plan in 1975. The Basin Plan was revised and updated in 1989 and 1994. The current edition (Fourth Edition 1998) incorporates two new amendments adopted since 1994. A Basin Plan is the basis for regulatory actions that are to be taken for control of water quality. The Basin Plan is also used to satisfy Section 303 of the Clean Water Act, which requires states to adopt water quality standards to meet federal regulatory requirements. Basin Plans are adopted and amended by the Regional Water Board using a structured process involving full public participation and State environmental review. A Basin Plan must include the following:

1. Beneficial uses to be protected.
2. Water quality objectives.
3. An implementation plan needed for achieving water quality objectives.

The proposed Basin Plan amendment for control of mercury in Clear Lake will be legally applicable once the amendment is adopted by the Regional Water Board and approved by the State Water Resources Control Board, State Office of Administrative Law, and the U.S. Environmental Protection Agency (USEPA). Implementation will begin after the Basin Plan amendment is legally applicable.

If adopted, the Basin Plan amendment would result in: 1) addition of the commercial and sport fishing beneficial use (COMM) to Clear Lake; 2) site-specific, numeric water quality objectives for methylmercury in fish of Clear Lake; and 3) an implementation plan for reducing mercury in Clear Lake. The purpose of this staff report is to present the proposed Basin Plan amendment and to provide the rationale behind each part of the amendment. Section 1 provides an introduction and background for the Basin Plan amendment process. Section 2 presents the proposed changes to the Basin Plan and the language revisions proposed for adoption by the Regional Water Board. Section 3 describes beneficial uses and existing conditions of Clear Lake. Section 4 presents the evaluation of possible water quality objectives. Section 5 describes the several alternatives for implementation that staff considered. Section 6 details the monitoring and surveillance plan proposed for Clear Lake. Section 7 provides the California Environmental Quality Act (CEQA) documentation and checklist. Appendix E provides the reference for the *Clear Lake Total Maximum Daily Load for Mercury Final Report*; this final report formed the basis of many parts of the proposed Basin Plan amendment and accompanying staff report.

## 1.1 Watershed Area to Be Considered

The proposed Basin Plan amendment recommends addition of the COMM beneficial use and water quality objectives that were developed specifically for Clear Lake, Lake County. These water quality objectives would also apply to wetland areas on the perimeter of and connected to Clear Lake. Implementation options are presented for Clear Lake and its tributaries.

Clear Lake is located in the Coast Range in Lake County, California. It is a shallow, eutrophic waterbody that has a length of approximately 18 miles and a surface area of approximately 43,000 acres. It is the largest natural lake located entirely within California's boundaries. Clear Lake is comprised of three distinct basins: the northern large, circular Upper Arm, the elongated southeast-trending Lower Arm, and the relatively small Oaks Arm located to the east (Figure 1). The mean depth of the basins ranges from 23 feet in the Upper Arm to 36 feet in Oaks Arm. The lake empties at the southern end of the Lower Arm into the south fork of Cache Creek.

The Clear Lake watershed has an area of approximately 337,000 acres, approximately 75% of which drains into the Upper Arm. Watersheds of Scott's Creek and Middle Creek contribute 30% of the total inflow to the lake (Richerson et al., 1994). Major land uses in the Clear Lake watershed are crop land, range land and irrigated pasture (Jones & Stokes Associates, 2001). Primary crops grown in the watershed are wine grapes, pears and walnuts. Acreage devoted to vineyards has increased substantially since 1990. Undeveloped land is managed under private ownership, the U.S. Forest Service, and the U. S. Bureau of Land Management.

Groundwater in the Clear Lake region is typically characterized by shallow aquifers that flow from the mountains into Clear Lake (USEPA, 1994). It is believed that there is little groundwater seepage lost from Clear Lake due to the low permeability of the underlying Franciscan Formation. The U.S. Geological Survey has mapped numerous hot springs discharging in the area (Sims and Rymer, 1976). Many of these springs vent directly into Clear Lake.

Several small communities and resorts surround the perimeter of Clear Lake. The largest in the area is the City of Clearlake (population 15,200), located adjacent to the Lower Arm, north of the south fork of Cache Creek. The communities of Nice, Lucerne, and Lakeport are located adjacent to the Upper Arm; Clearlake Oaks is located adjacent to the Oaks Arm; and Lower Lake is adjacent to the Lower Arm, south of Cache Creek. The Elem Tribe of Southeastern Pomo Native Americans (also referred to as Elem Tribal Colony or Sulphur Bank Rancheria) live along the eastern perimeter of Oaks Arm. The local economy is heavily dependent upon tourism, fishing and agriculture (USEPA, 1994).

The Clear Lake watershed lies within a region naturally enriched in mercury. The Sulphur Bank Mercury Mine (SBMM) was a highly productive source of mercury between 1880 and 1957. The SBMM site is located on the east shore of Oaks Arm, south of the Elem Tribal land. Several small mines are also located in the Clear Lake watershed. All mercury mines in the basin are now inactive.

### 1.2 Need for an Amendment to the Basin Plan

Section 303(d)(1)(A) of the Clean Water Act requires the California Regional Water Quality Control Boards to:

- Identify the Region's waters that do not comply with water quality standards applicable to such waters;

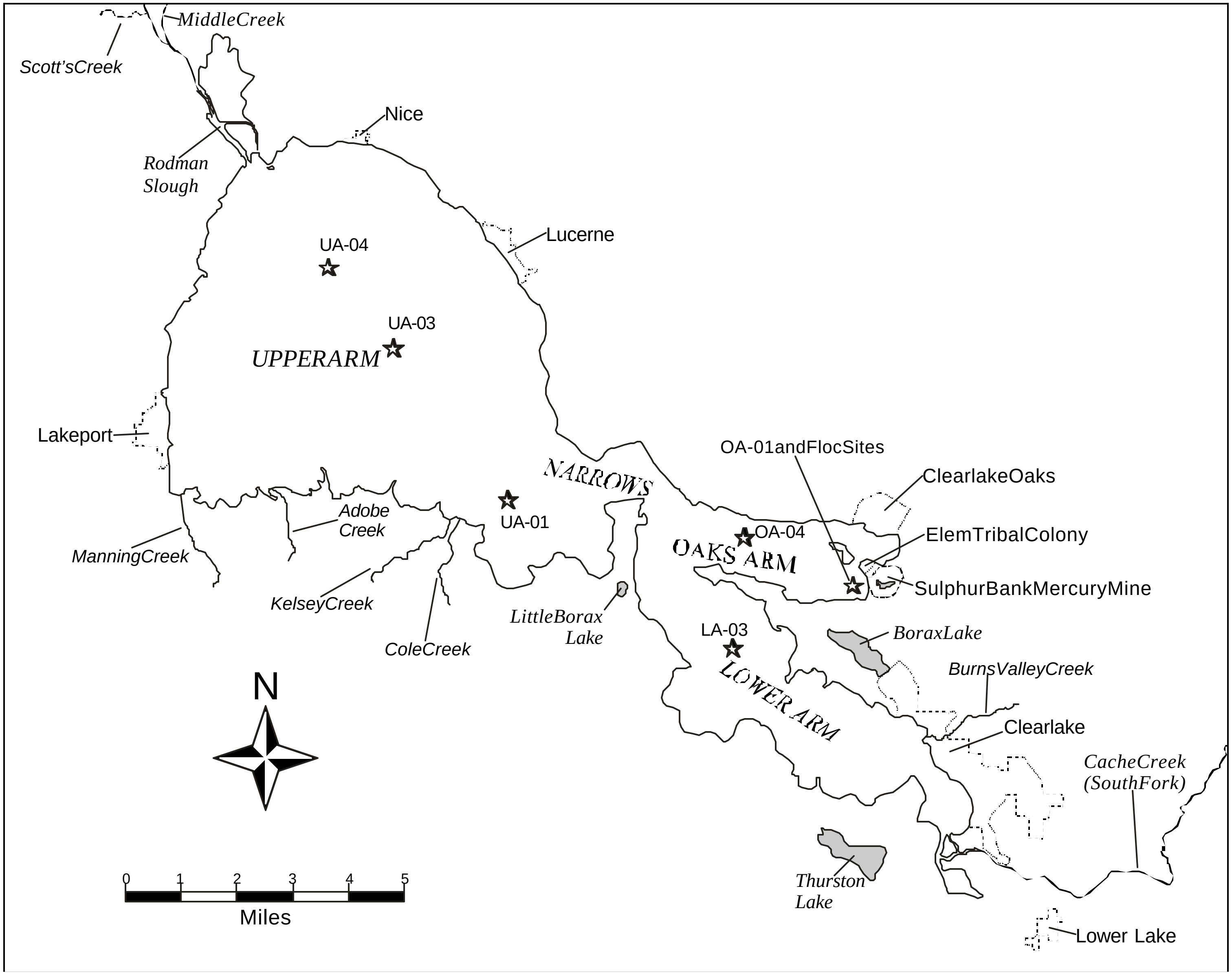


Figure 1. Map of Clear Lake and Selected UC Davis Sampling Sites
(Sources: U.S. Geological Survey 7.5 Minute Quadrangles, 1990-1993, Suchanek et al., 1997.)

- Rank the impaired waterbodies, taking into account factors including the severity of the pollution and the uses made of such waters; and
- Establish water quality management strategies (Total Maximum Daily Loads; TMDLs) for those pollutants causing the impairments to ensure that impaired water attain their beneficial uses.

In 1988, the Regional Water Board identified Clear Lake as impaired due to mercury and recommended that it be placed on the 303(d) List of Impaired Waterbodies. The Regional Water Board based its recommendation to list Clear Lake on the elevated levels of mercury in fish tissue and the existence of a fish consumption advisory. The health advisory recommending limited consumption of fish from Clear Lake was issued by the California Department of Health Services in 1987 (Stratton et al., 1987).

The Regional Water Board will develop a water quality management strategy for each waterbody and pollutant in the Central Valley identified on California's 303(d) List. The management strategy for control of mercury in Clear Lake will be conducted in several phases:

- <u>Total Maximum Daily Load Development</u>: involves the technical analysis of the sources of pollutant, the fate and transport of those pollutants, the numeric target(s), and the amount of pollutant reduction that is necessary to attain the target. The draft version of the *Clear Lake TMDL for Mercury Final Report* was released to the public for comment in the first week of December 2001. All comments received by 7 January 2002 were considered in preparation of the final version of the TMDL report, which was submitted to USEPA in February 2002. The *Clear Lake TMDL for Mercury Final Report* formed the basis of many parts of the proposed Basin Plan amendment and accompanying staff report.
- <u>Basin Planning</u>: focuses on the development of a Basin Plan amendment and a Functionally Equivalent Document for Regional Water Board consideration. The Basin Plan amendment will include those policies and regulations that the Regional Water Board believes are necessary to attain water quality objectives. The Functionally Equivalent Document includes information and analyses required to comply with the California Environmental Quality Act.
- <u>Implementation</u>: focuses on the establishment of a framework that ensures that appropriate practices or technologies are implemented (§13241 and §13242 of the Porter-Cologne Water Quality Act), including those elements necessary to meet federal TMDL requirements (CWA Section 303(d)).

The narrative water quality objective for toxicity in the Basin Plan states, in part, "All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life." The narrative toxicity objective further states that "The Regional Water Board will also consider … numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U.S. Food and Drug Administration, the National Academy of Sciences, the U.S. Environmental Protection Agency, and other appropriate organizations to evaluate compliance with this objective." (CVRWQCB, 1998). At this time, the Basin Plan does not include numeric water quality objectives for mercury or an implementation plan to control mercury in Clear Lake. Therefore, the Regional Water Board staff propose that the Basin Plan be amended to include these elements.

# 2 PROPOSED AMENDMENT TO THE BASIN PLAN

## 2.1 Summary of the Proposed Amendment

Proposed modifications to the Basin Plan include:

1. Addition of the commercial and sport fishing beneficial use (COMM) to Clear Lake;
2. A site-specific numeric water quality objective for methylmercury in Clear Lake; and
3. A water quality management strategy for mercury in Clear Lake.

The text on the following pages contains the proposed modifications. Text additions are indicated by underline and text deletions are indicated by ~~strikethrough~~. The first page of each Basin Plan chapter proposed for modification is included to assist the reader. Basin Plan pages that do not have modifications are not included. Following is a summary of the proposed Basin Plan modifications.

**Basin Plan Chapter I (Introduction)**
No modifications to Basin Plan Chapter 1 (Introduction) are proposed.

**Basin Plan Chapter II (Existing and Potential Beneficial Uses)**
The proposed modification to the Existing and Potentia l Uses Chapter includes addition of the commercial and sport fishing (COMM) beneficial use for Clear Lake. The proposed change is the addition of a footnote to Table II-1 to indicate that commercial and sport fishing beneficial uses exist at Clear Lake in addition to the other beneficial uses listed in Table II-1. No deletions are proposed for Chapter II. The rational for the beneficial use designation is provided in Section 3 of this Staff report.

**Basin Plan Chapter III (Water Quality Objectives)**
The proposed modification to the Water Quality Objectives Chapter includes addition of a site specific, numeric water quality objective for methylmercury in Clear Lake. The proposed addition to Chapter III consists of a new subheading labeled **Methylmercury** and a description of the water quality objective. No deletions are proposed for Chapter III. A detailed description and rational for the proposed water quality objective is provided in Section 4 of this staff report.

**Basin Plan Chapter IV (Implementation)**
The proposed modification to the Implementation Chapter includes a water quality management strategy for mercury in Clear Lake.

The proposed modification to Chapter IV adds Black Butte Reservoir and Lake Pilsbury to the list of waterbodies for which fish consumption advisories have been issued. The proposed modification also adds guidelines the USEPA to the list of mercury guidelines that are exceeded in the region. Advisories for these waterbodies and the new USEPA guidelines were issued since the latest edition of the Basin Plan.

The proposed modification to Chapter IV deletes two sentences describing an abatement study at Clear Lake for the Sulphur Bank Mercury Mine. The modification also proposes a new subheading labeled **Clear Lake Mercury** and a description of a strategy to reduce mercury loads to Clear Lake. A detailed description of the water quality management strategy for mercury is provided in Section 5 of this staff report.

**Basin Plan Chapter V (Surveillance and Monitoring)**
The proposed modification to the Surveillance and Monitoring Chapter includes a monitoring program for methylmercury in Clear Lake. No deletions are proposed for Chapter V. The description of the monitoring program is provided in Section 6 of this report.

**Basin Plan Appendix**
No modifications to the Basin Plan Appendix are proposed.

### 2.2 Proposed Modifications to Basin Plan Chapter II (Existing and Potential Beneficial Uses)

The proposed changes to Chapter II (Existing and Potential Beneficial Uses) consist of the addition of the commercial and sport fishing (COMM) beneficial uses for Clear Lake. See Table II-1 on the following two pages. The proposed changes include a new footnote in Table II-1 under the column "Surface Water Bodies" for the Clear Lake entry to read "Clear Lake (a)" and the addition of "Clear Lake: COMM" under footnote "a" at the end of Table II-1.

# SURFACE WATER BODIES AND BENEFICIAL USES

| | SURFACE WATER BODIES (1) | HYDRO UNIT NUMBER | MUN | AGRICULTURE | | INDUSTRY | | | RECREATION | | | FRESHWATER HABITAT (2) | | MIGRATION | | SPAWNING | | WILD | NAV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MUN | AGR | | PROC | IND | POW | REC-1 | | REC-2 | WARM | COLD | MIGR | | SPWN | | WILD | NAV |
| | | | MUNICIPAL AND DOMESTIC SUPPLY | IRRIGATION | STOCK WATERING | PROCESS | SERVICE SUPPLY | POWER | CONTACT | CANOEING AND RAFTING (1) | OTHER NONCONTACT | WARM | COLD | WARM (3) | COLD (4) | WARM (3) | COLD (4) | WILDLIFE HABITAT | NAVIGATION |
| 30 | COLUSA BASIN DRAIN TO EYE ["I"] STREET BRIDGE | 520.00 | E | E | | | | | E | E | E | E | E | E | E | E | E | E | E |
| 31 | SUTTER BYPASS | 520.3 | | E | | | | | E | | | E | | | E | | E | E | |
| | FEATHER RIVER | | | | | | | | | | | | | | | | | | |
| 32 | LAKE ALMANOR | 518.41 | | | | | | E | E | | | E | E | | | E | | E | |
| 33 | NORTH FORK, FEATHER RIVER | 518.4 | E | | | | | E | E | E | E | | E | | | | E | E | |
| | MIDDLE FORK, FEATHER RIVER | 518.3 | | | | | | | | | | | | | | | | | |
| 34 | SOURCE TO LITTLE LAST CHANCE CREEK | 518.35 | | E | E | | | | E | E | E | E | E | | | | E | E | |
| 35 | FRENCHMAN RESERVOIR | 518.36 | | | | | | | E | | E | P | E | | | | E | E | |
| 36 | LITTLE LAST CHANCE CREEK TO LAKE OROVILLE | 518.3 | E | | | | | | E | E | E | E | E | | | | E | E | |
| 37 | LAKE DAVIS | 518.34 | | | | | | | E | | E | P | E | | | | E | E | |
| 38 | LAKES BASIN LAKES | 518.5 | | | | | | | E | | E | | E | | | | E | E | |
| 39 | LAKE OROVILLE | 518.12 | E | E | | | | E | E | | E | E | E | | | E | E | E | |
| 40 | FISH BARRIER DAM TO SACRAMENTO RIVER | 515. | E | E | | | | | E | E | E | E | E | E | E | E | E | E | |
| | YUBA RIVER | | | | | | | | | | | | | | | | | | |
| 41 | SOURCES TO ENGLEBRIGHT RESERVOIR | 517. | E | E | E | | | E | E | E | E | | E | | | | E | E | |
| 42 | ENGLEBRIGHT DAM TO FEATHER RIVER | 515.3 | | E | E | | | E | E | E | E | E | E | E | E | E | E | E | |
| 43 | BEAR RIVER | 515.1 | E | E | E | | | E | E | E | E | E | E | P | P | P | P | E | |
| | AMERICAN RIVER | | | | | | | | | | | | | | | | | | |
| 44 | NORTH FORK, SOURCE TO FOLSOM LAKE | 514.5 | E | E | | | | | E | E | E | P | E | | | | E | E | |
| 45 | MIDDLE FORK, SOURCE TO FOLSOM LAKE | 514.4 | E | E | E | | | E | E | E | E | P | E | | | | E | E | |
| 46 | DESOLATION VALLEY LAKES | 514.4 | | | | | | | E | | E | | E | | | | E | E | |
| | SOUTH FORK | 514.3 | | | | | | | | | | | | | | | | | |
| 48 | SOURCE TO PLACERVILLE | 514.3 | E | | | | | E | E | E | E | P | E | | | | E | E | |
| 49 | PLACERVILLE TO FOLSOM LAKE | 514.32 | E | E | | | | E | E | E | E | E | E | | | | | E | |
| 50 | FOLSOM LAKE | 514.23 | E | E | | | P | E | E | | E | E | E | | | E | | E | |
| 51 | FOLSOM DAM TO SACRAMENTO RIVER | 519.21 | E | E | | | E | E | E | E | E | E | E | E | E | E | E | E | |
| 52 | YOLO BYPASS | 510. | | E | E | | | | E | | E | E | P | E | E | E | | E | |
| | CACHE CREEK | | | | | | | | | | | | | | | | | | |
| 53 | CLEAR LAKE (a) | 513.52 | E | E | E | | | | E | | E | E | P | | | E | | E | |
| 54 | CLEAR LAKE TO YOLO BYPASS | 511/513 | E | E | E | E | E | | E | E | E | E | P | | | E | E | E | |

(1) Shown for streams and rivers only with the implication that certain flows are required for this beneficial use.
(2) Resident does not include anadromous. Any Segments with both COLD and WARM beneficial use designations will be considered COLD water bodies for the application of water quality objectives.
(3) Striped bass, sturgeon, and shad.
(4) Salmon and steelhead
(5) As a primary beneficial use.
(6) The indicated beneficial uses are to be protected for all waters except in specific cases where evidence indicates the appropriateness of additional or alternative beneficial use designations.
(7) Sport fishing is the only recreation activity permitted.
(8) Beneficial uses vary throughout the Delta and will be evaluated on a case-by-case basis.
(9) Per State Board Resolution No. 90-28, Marsh Creek and Marsh Creek Reservoir in Contra Costa County are assigned the following beneficial uses: REC1 and REC2

A/ Hidden Reservoir = Hensley Lake
B/ Buchanan Reservoir = Eastman Lake

## SURFACE WATER BODIES AND BENEFICIAL USES

| | SURFACE WATER BODIES (1) | | | AGRI-CULTURE | | INDUSTRY | | | RECREATION | | | FRESHWATER HABITAT (2) | | MIGRATION | | SPAWNING | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MUN | AGR | | PROC | IND | POW | REC-1 | | REC-2 | WARM | COLD | MIGR | | SPWN | | WILD | NAV |
| | | HYDRO UNIT NUMBER | MUNICIPAL AND DOMESTIC SUPPLY | IRRIGATION | STOCK WATERING | PROCESS | SERVICE SUPPLY | POWER | CONTACT | CANOEING AND RAFTING (1) | OTHER NONCONTACT | WARM | COLD | WARM (3) | COLD (4) | WARM (3) | COLD (4) | WILDLIFE HABITAT | NAVIGATION |
| | MERCED RIVER | | | | | | | | | | | | | | | | | | |
| 78 | SOURCE TO McCLURE LAKE | 537. | P | E | | | | E | E | E | E | E | E | | | | | E | |
| 79 | McCLURE LAKE | 537.22 | P | E | | | | E | E | | E | E | E | | | | | E | |
| 80 | McSWAIN RESERVOIR | 537.1 | P | E | | | | E | E | | E | E | E | | | | | E | |
| 81 | McSWAIN RESERVOIR TO SAN JOAQUIN RIVER | 535. | E | | E | E | E | E | E | E | E | E | E | E | E | E | E | E | |
| 82 | YOSEMITE LAKE | 535.9 | | | | | | | E | | E | E | E | | | | | E | |
| 83 | MOUTH OF MERCED RIVER TO VERNALIS | 535/541 | P | E | E | E | | | E | E | E | E | | E | E | E | | E | |
| | TUOLUMNE RIVER | | | | | | | | | | | | | | | | | | |
| 84 | SOURCE TO [NEW] DON PEDRO RESERVOIR | 536. | E | E | E | | | E | E | E | E | E | E | | | | | E | |
| 85 | NEW DON PEDRO RESERVOIR | 536.32 | P | | | | | E | E | | E | E | E | | | | | E | |
| 86 | NEW DON PEDRO DAM TO SAN JOAQUIN RIVER | 535. | P | E | E | | | | E | E | E | E | E | | E | E | E | E | |
| | STANISLAUS RIVER | | | | | | | | | | | | | | | | | | |
| 87 | SOURCE TO NEW MELONES RESERVOIR (PROPOSED) | 534. | E | E | E | | | E | E | E | E | E | E | | | | | E | |
| 88 | NEW MELONES RESERVOIR | 534.21 | E | E | E | | | E | E | | E | | E | | | | | E | |
| 89 | TULLOCH RESERVOIR | 534.22 | P | E | E | | | E | E | | E | E | | | | | | E | |
| 90 | GOODWIN DAM TO SAN JOAQUIN RIVER | 535. | P | E | E | E | E | E | E | E | E | E | E | | E | E | E | E | |
| 91 | SAN LUIS RESERVOIR | 542.32 | E | E | E | | E | E | E | | E | E | | | | | | E | |
| 92 | O'NEILL RESERVOIR | 541.2 | E | E | E | | | | E | | E | E | | | | | | | |
| 93 | OTHER LAKES AND RESERVOIRS IN SAN JOAQUIN R. BASIN, (EXCLUDING HYDRO UNIT NOS. 531-533, 543, 544) (6) | | E | | | | | E | E | | E | E | E | | | | E | E | |
| 94 | CALIFORNIA AQUEDUCT | 541. | E | E | E | E | E | E | E | | E | | | | | | | E | |
| 95 | DELTA-MENDOTA CANAL | 541/543 | E | E | E | | | | E | | E | E | | | | | | E | |
| | GRASSLAND WATERSHED [a] | 541.2 | | | | | | | | | | | | | | | | | |
| 96 | MUD SLOUGH (NORTH) | | | L (b) | E | | | | E | | E | E | | | | E | | E | |
| 97 | SALT SLOUGH | | | E | E | | | | E | | E | E | | | | E | | E | |
| 98 | WETLAND WATER SUPPLY CHANNELS (10) | | | L (b) | E | | | | | | | L (c) | | | | | | E | |
| C | SACRAMENTO SAN JOAQUIN DELTA (8, 9) | 544. | E | E | E | E | E | | E | | E | E | E | E | E | E | | E | E |

(1) Shown for streams and rivers only with the implication that certain flows are required for this beneficial use.
(2) Resident does not include anadromous. Any Segments with both COLD and WARM beneficial use designations will be considered COLD water bodies for the application of water quality objectives.
(3) Striped bass, sturgeon, and shad.
(4) Salmon and steelhead
(5) As a primary beneficial use.
(6) The indicated beneficial uses are to be protected for all waters except in specific cases where evidence indicates the appropriateness of additional or alternative beneficial use designations.
(7) Sport fishing is the only recreation activity permitted.
(8) Beneficial uses vary throughout the Delta and will be evaluated on a case-by-case basis.
(9) Per State Board Resolution No. 90-28, Marsh Creek and Marsh Creek Reservoir in Contra Costa County are assigned the following beneficial uses: REC1 and REC2
(10) Wetland water supply channels for which beneficial uses are designated are defined in Appendix 40

(a) The following beneficial uses EXIST in addition to those noted in Table II-1

Mud Slough (north): COMM and SHELL
Salt Slough: COMM, BIOL, and SHELL
Wetland Water Supply Channels: BIOL
<u>Clear Lake: COMM</u>

(b) Elevated natural salt and boron concentrations may limit this use to irrigation of salt and boron tolerant crops. Intermittent low flow conditions may also limit this use

(c) Wetland channels can sustain aquatic life, but due to fluctuating flow regimes and habitat limitations, may not be suitable for nesting and/or propagation.

## 2.3 Proposed Modifications to Basin Plan Chapter III (Water Quality Objectives)



The Porter-Cologne Water Quality Control Act defines water quality objectives as "...the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" [Water Code Section 13050(h)]. It also requires the Regional Water Board to establish water quality objectives, while acknowledging that it is possible for water quality to be changed to some degree without unreasonably affecting beneficial uses. In establishing water quality objectives, the Regional Water Board must consider, among other things, the following factors:

- Past, present, and probable future beneficial uses;
- Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto;
- Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;
- Economic considerations;
- The need for developing housing within the region;
- The need to develop and use recycled water. (Water Code Section 13241)

The Federal Clean Water Act requires a state to submit for approval of the Administrator of the U.S. Environmental Protection Agency *(USEPA)* all new or revised water quality standards which are established for surface and ocean waters. As noted earlier, California water quality standards consist of both beneficial uses (identified in Chapter II) and the water quality objectives based on those uses.

There are **seven important points** that apply to water quality objectives.

The **first point** is that water quality objectives can be revised through the basin plan amendment process. Objectives may apply region-wide or be specific to individual water bodies or parts of water bodies. Site-specific objectives may be developed whenever the Regional Water Board believes they are appropriate. As indicated previously, federal regulations call for each state to review its water quality standards at least every three years. These Triennial Reviews provide one opportunity to evaluate changing water quality objectives, because they begin with an identification of potential and actual water quality problems, i.e., beneficial use impairments. Since impairments may be associated with water quality objectives being exceeded, the Regional Water Board uses the results of the Triennial Review to implement actions to assess, remedy, monitor, or otherwise address the impairments, as appropriate, in order to achieve objectives and protect beneficial uses. If a problem is found to occur because, for example, a water quality objective is too weak to protect beneficial uses, the Basin Plan should be amended to make the objective more stringent. (Better enforcement of the water quality objectives or adoption of certain policies or redirection of staff and resources may also be proper responses to water quality problems. See the Implementation chapter for further discussion.)

Changes to the objectives can also occur because of new scientific information on the effects of water contaminants. A major source of information is the USEPA, which develops data on the effects of chemical and other constituent concentrations on particular aquatic species and human health. Other information sources for data on protection of beneficial uses include the National Academy of Science which has published data on bioaccumulation and the Federal Food and Drug Administration which has issued criteria for unacceptable levels of chemicals in fish and shellfish used for human consumption. The Regional Water Board may make use of those and other state or federal agency information sources in assessing the need for new water quality objectives.

The **second point** is that achievement of the objectives depends on applying them to controllable water quality factors. *Controllable water quality factors* are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Water Board or the Regional Water Board, and that may be reasonably controlled. Controllable factors are not

## Color

Water shall be free of discoloration that causes nuisance or adversely affects beneficial uses.

## Dissolved Oxygen

Within the legal boundaries of the Delta, the dissolved oxygen concentration shall not be reduced below:

> 7.0 mg/l in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge; 6.0 mg/l in the San Joaquin River (between Turner Cut and Stockton, 1 September through 30 November); and 5.0 mg/l in all other Delta waters except for those bodies of water which are constructed for special purposes and from which fish have been excluded or where the fishery is not important as a beneficial use.

For surface water bodies outside the legal boundaries of the Delta, the monthly median of the mean daily dissolved oxygen *(DO)* concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percentile concentration shall not fall below 75 percent of saturation. The dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time:

> Waters designated WARM 5.0 mg/l
> Waters designated COLD 7.0 mg/l
> Waters designated SPWN 7.0 mg/l

The more stringent objectives in Table III-2 apply to specific water bodies in the Sacramento and San Joaquin River Basins:

**TABLE III-2**
**SPECIFIC DISSOLVED OXYGEN WATER QUALITY OBJECTIVES**

| AMOUNT | TIME | PLACE |
|---|---|---|
| 9.0 mg/l * | 1 June to 31 August | Sacramento River from Keswick Dam to Hamilton City (13) |
| 8.0 mg/l | 1 September to 31 May | Feather River from Fish Barrier Dam at Oroville to Honcut Creek (40) |
| 8.0 mg/l | all year | Merced River from Cressy to New Exchequer Dam (78) |
| 8.0 mg/l | 15 October to 15 June | Tuolumne River from Waterford to La Grange (86) |

When natural conditions lower dissolved oxygen below this level, the concentrations shall be maintained at or above 95 percent of saturation.

## Floating Material

Water shall not contain floating material in amounts that cause nuisance or adversely affect beneficial uses.

## Methylmercury

For Clear Lake (53), the methylmercury concentration in fish tissue shall not exceed 0.09 and 0.19 mg methylmercury/kg wet weight of tissue in trophic level 3 and 4 fish, respectively. Compliance with these objectives shall be determined by analysis of fish tissue as described in Chapter V, Surveillance and Monitoring.

## 2.4 Proposed Modifications to Basin Plan Chapter IV (Implementation)

# IV. IMPLEMENTATION

The Porter-Cologne Water Quality Control Act states that basin plans consist of beneficial uses, water quality objectives and a program of implementation for achieving their water quality objectives [Water Code Section 13050(j)]. The implementation program shall include, but not be limited to:

1. A description of the nature of actions which are necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or private;

2. A time schedule for the actions to be taken; and,

3. A description of surveillance to be undertaken to determine compliance with the objectives (Water Code Section 13242).

In addition, State law requires that basin plans indicate estimates of the total cost and identify potential sources of funding of any agricultural water quality control program prior to its implementation. (Water Code Section 13141). This chapter of the Basin Plan responds to all but the surveillance requirement. That is described in Chapter V.

This chapter is organized as follows: The first section contains a general description of water quality concerns. These are organized by discharger type (e.g., agriculture, silviculture, mines, etc.). The second section lists programs, plans and policies which should result in the achievement of most of the water quality objectives in this plan. This section includes descriptions of State Water Board policies, statewide plans, statewide programs dealing with specific waste discharge problems (e.g., underground tanks, storm water, solid waste disposal sites, etc.), memoranda of understanding, management agency agreements, memoranda of agreement, Regional Water Board policies, a listing of Regional Water Board prohibition areas, and Regional Water Board guidelines addressing specific water quality problems. The third section contains recommendations for appropriate action by entities other than the Regional Water Board. The fourth section describes how; within the framework of the programs, plans and policies discussed in the second section; the Regional Water Board integrates water quality control activities into a continuing planning process. The fifth section identifies the current actions and the time schedule for future actions of the Regional Water Board to achieve compliance with water quality objectives where the programs, plans and policies in the second section are not adequate. The last section lists the estimated costs and funding sources for agricultural water quality control programs that are implemented by the Regional Water Board.

## WATER QUALITY CONCERNS

Water quality concerns are existing or potential water quality problems, i.e., impairments of beneficial uses or degradations of water quality. At any given time, water quality problems generally reflect the intensity of activities of key discharge sources and the volume, quality, and uses of the receiving waters affected by the discharges.

Historic and ongoing point and nonpoint source discharges impact surface waters. Significant portions of major rivers and the Delta are impaired, to some degree, by discharges from agriculture, mines, urban areas and industries. Upstream, small streams and tributaries to the Rivers are impaired or threatened because of discharges from mines, silviculture activities, and urban development activities. Control approaches may differ depending on the source of the problem.

A variety of historic and ongoing point and non-point industrial, urban, and agricultural activities degrade the quality of ground water. Discharges to ground water associated with these activities include industrial and agricultural chemical use and spills; underground and above ground tank and sump leaks; landfill leachate and gas releases; septic tank failures; improper animal waste management; and chemical seepage via shallow drainage wells and abandoned wells. The resulting impacts on ground water quality from these discharges are often long-term and costly to treat or remediate. Consequently, as discharges are identified, containment and cleanup of source areas and plumes must be undertaken as quickly as possible. Furthermore, activities that may potentially impact ground water must be managed to ensure that ground water quality is protected.

Improper management of waste materials and spillage of industrial fluids have degraded or polluted ground water resources beneath military bases, rail yards, wood treating facilities, aerospace manufacturing and testing operations, municipal gas effects of total metals loadings and dissolved metals concentrations.

The Regional Water Board plans to develop a mass emission strategy to control the loads of metals entering receiving waters and the Delta. Although the strategy will focus on control of discharges from inactive and abandoned mines, reasonable steps will also be taken to limit loads of metals from other significant sources. The Regional Water Board also plans to continue to monitor for metals in the Delta and principal tributaries to the Delta to assess compliance with water quality objectives, to assess impacts on beneficial uses, and to coordinate monitoring and metal reduction programs with the San Francisco Regional Water Quality Control Board.

Where circumstances warrant, the Regional Water Board will support action to clean up and abate pollution from identified sources. Funds from the State Water Pollution Cleanup and Abatement Account have been and are being used to clean up and abate discharges from selected abandoned or inactive mines. Abatement projects are underway at Iron Mountain Mine, Walker Mine, Mammoth Mine, Balaklala Mine, Keystone Mine, Stowell Mine, and Penn Mine, as data show that these mines are the most significant sources in terms of total metals discharged to receiving waters.

However, recent judicial decisions have imposed liability on the Regional Water Board for its cleanup actions at the Penn Mine. As long as the risk of such liability exists, the Regional Water Board will likely choose not to perform cleanup at any additional sites. Action by the State Legislature or the Congress will probably be required to resolve concerns of liability and facilitate the State's role in site remediation.

The Regional Water Board also will seek additional resources to update the Regional Abandoned Mines Inventory, to establish a monitoring program to track metals across the Delta and into the Bay, and to determine what loads the Delta can assimilate without resulting in adverse impacts. Although most of the significant mine portal discharges are in the process of being controlled, others need studies to determine their potential for cleanup. Since a major uncharacterized source of metals are the tailings piles associated with the mines, studies are needed to define the loads from these sources in order to establish priorities for abatement activities.

## Mercury Discharges in the Sacramento River and San Joaquin River Basins

Mercury problems are evident region-wide. The main concern with mercury is that, like selenium, it bioaccumulates in aquatic systems to levels that are harmful to fish and their predators. Health advisories have been issued which recommend limiting consumption of fish taken from the Bay/Delta, Clear Lake, Lake Berryessa, Black Butte Reservoir, Lake Pilsbury, and Marsh Creek Reservoir. Concentrations of mercury in ~~O~~other water bodies approach or exceed National Academy of Science (NAS), U.S. Environmental Protection Agency (EPA), and/or U.S. Food and Drug Administration (FDA) guidelines for wildlife and human protection, ~~respectively~~. In addition to these concerns, fish-eating birds taken from some bodies of water in the Basins have levels of mercury that can be expected to cause toxic effects. Bird-kills from mercury also have been documented in Lake Berryessa. (There is also concern for birds in the Delta, but no studies have been completed.) The Regional Water Board has done a preliminary assessment of the mercury situation in the Central Valley Region and concluded that the problem is serious and remedies will be complex and expensive.

The short-term strategy is to concentrate on correcting problems at upstream sites while monitoring the Delta to see whether upstream control activities measurably benefit the Delta. The Regional Water Board will support efforts to fund the detailed studies necessary to define assimilative capacity and to fully define uptake mechanisms in the biota.

~~An abatement study was completed for Clear Lake in 1990. The study identified abatement measures at Sulfur Bank Mine that are now being implemented as part of a USEPA Superfund project.~~ In the next few years monitoring is scheduled to be done in the Delta and at upstream sources. The Regional Water Board will continue to support efforts to study how mercury is cycled through the Delta and to further characterize upstream sources.

## Clear Lake Mercury

The Regional Water Board has a goal to reduce methylmercury concentrations in Clear Lake fish by reducing total mercury loads from various sources within the Clear Lake watershed.

Sources of mercury include past and present discharges from the Sulphur Bank Mercury Mine (SBMM) site, natural and anthropogenic erosion of soils with naturally occurring mercury, and atmospheric deposition. The goal of the Clear Lake mercury management strategy is to reduce fish tissue methylmercury concentrations by 60% of existing levels. This will be accomplished by reducing the concentration of total mercury in the surficial layer of lakebed sediment by 70% of existing levels and by further investigation and reduction of other mercury sources believed to have a high potential for mercury methylation. Through a complex process, total mercury is methylated and becomes bioavailable to organisms in the food web. The linkage between (1) the total mercury in the sediments derived from various sources and other sources of total mercury and (2) the concentration of methylmercury in ecological receptors, is complicated and subject to uncertainty. As additional information about these relationships becomes available, the Regional Water Board will revise and refine as appropriate the load allocation and implementation strategy to achieve fish tissue objectives.

*Mercury Load Allocations*

The strategy for meeting the fish tissue objectives is to reduce the inputs of mercury to the lake from tributaries and the SBMM site, combined with active and passive remediation of contaminated lake sediments. The load allocations for Clear Lake will result in a reduction in the overall mercury sediment concentration by 70% of existing concentrations. The load allocations are assigned to the active sediment layer of the lakebed, the SBMM terrestrial site, the tributary creeks and surface water runoff to Clear Lake, and atmospheric deposition. Table IV-5 summarizes the load allocations. The load allocation to the active sediment layer is expressed as reducing concentrations of total mercury in the active sediment layer to 30% of current concentrations. The load allocation to the SBMM terrestrial site is 5% of the ongoing loads from the terrestrial mine site. The load allocation for the mine also includes reducing mercury concentrations in surficial sediment to achieve the sediment compliance goals for Oaks Arm shown in Table IV-6. The load allocation to tributary and surface water runoff is 80% of existing loads. These load allocations account for seasonal variation in mercury loads, which vary with water flow and rainfall. The analysis includes an implicit margin of safety in the reference doses for methylmercury that were used to develop the fish tissue objectives. It also includes an explicit margin of safety of 10% to account for uncertainty in the relationship between fish tissue concentrations and loads of total mercury. The reductions in loads of total mercury from all sources are expected to result in attainment of water quality objectives.

**TABLE IV-5**
**MERCURY LOAD ALLOCATIONS**

| Mercury Source | Allocation (% of Existing Load) |
|---|---|
| Clear Lake Sediment | 30% |
| Sulphur Bank Mine | 5% |
| Tributaries | 80% |
| Atmosphere | No change |

*Sulphur Bank Mercury Mine*

Reducing mercury concentrations in surficial sediment by 70% is an overall goal for the entire lake. To achieve water quality objectives, extremely high levels of mercury in the eastern end of Oaks Arm near SBMM must be reduced by more than 70%. To evaluate progress in lowering sediment concentrations, the following sediment compliance goals are established at sites that have been sampled previously.

**TABLE IV-6**
**SEDIMENT COMPLIANCE GOALS FOR MERCURY IN CLEAR LAKE**

| Site Designation | Location | Sediment Mercury Goal (a) (mg/kg dry weight) |
|---|---|---|
| Upper Arm UA-03 | Center of Upper Arm on transect from Lakeport to Lucerne | 0.8 |
| Lower Arm LA-03 | Center of Lower Arm, North and west of Monitor Point | 1 |
| Oaks Arm | | |
| OA-01 (c) | 0.3 km from SBMM | 16 (b) |
| OA-02 (c) | 0.8 km from SBMM | 16 (b) |
| OA-03 (c) | 1.8 km from SBMM | 16 |
| OA-04 (c) | 3 km from SBMM | 10 |
| Narrows O1 | 7.7 km from SBMM | 3 |

(a) Sediment goals are 30% of existing concentrations. Existing concentrations are taken as the average mercury concentrations in samples collected in 1996-2000 (Clear Lake Basin Plan Amendment Staff Report).
(b) Due to the exceptionally high concentrations existing at the eastern end of Oaks Arm, sediment goals at OA-01 and OA-02 are not 70% of existing concentrations. These goals are equal to the sediment goal established for OA-03.
(c) Sediment goal is part of the load allocation for SBMM.

Current and past releases from the Sulphur Bank Mercury Mine are a significant source of total mercury loading to Clear Lake. Ongoing annual loads from the terrestrial mine site to the lakebed sediments occur through groundwater, surface water, and atmospheric routes. Loads from ongoing releases from the terrestrial mine site should be reduced to 5% of existing inputs. Because of its high potential for methylation relative to mercury in lakebed sediments, mercury entering the lake through groundwater from the mine site should be reduced to 0.5 kg/year. Past releases from the mine site are a current source of exposure through remobilization of mercury that exists in the lakebed sediments as a result of past releases to the lake from the terrestrial mine site. Past active mining operations, erosion and other mercury transport processes at SBMM have contaminated sediment in Oaks Arm. The load allocation assigned to SBMM includes reducing surficial sediment concentrations in Oaks Arm by 70% (more at sites nearest the mine site) to meet the sediment compliance goals in Table IV-6.

In 1990, the U.S. Environmental Protection Agency (USEPA) placed Sulphur Bank Mercury Mine on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The USEPA has already performed remediation actions to stabilize waste rock piles, reduce erosion, and control surface water on the site.

Estimates of the current annual loads from the terrestrial mine site to the surficial lakebed sediment are under investigation. Existing data indicate that loads of total mercury from the terrestrial mine site are within a broad range of 1 to 568 kg mercury per year. New data may be used to refine the load estimates as discussed below. As part of verifying compliance with the load allocations, remediation activities to address current and past releases from SBMM should be conducted to meet the sediment compliance goals listed in Table IV-6 for sediments within one kilometer of the mine site, specifically at sites OA-01 and OA-02.

The Regional Water Board anticipates that fish tissue objectives for mercury will not be met unless the load reductions from Sulphur Bank Mercury Mine are attained. The Regional Water Board will request that USEPA continue remediation activities on the mine site and prepare an implementation plan or plans that address the following: reduction of ongoing releases of mercury from the SBMM site through surface water, groundwater, and the atmosphere; necessary remediation for mercury in lakebed sediments previously deposited through mining, erosion, and other processes at the mine site; and monitoring and review activities. The implementation plans should provide interim sediment goals and explain how control actions will assist in achieving fish tissue objectives for mercury in Clear Lake. The Regional Water Board will request that USEPA submit remediation plans for Regional Board approval for the SBMM site within eight years after the effective date of this amendment and implement the plan two years thereafter. USEPA should complete remediation activities at the mine site and active lakebed sediment remediation within ten years of plan implementation.

USEPA anticipates implementing additional actions to address the ongoing surface and groundwater releases from the SBMM over the next several years. These actions are expected to lead to significant reductions in the ongoing releases from the mine pit, the mine waste piles and other ongoing sources of mercury releases from the terrestrial mine site. USEPA also currently plans to investigate what steps are appropriate under CERCLA to address the existing contamination in the lakebed sediments due to past releases from the SBMM. Regional Water Board staff will continue to work closely with the USEPA on these important activities. In addition, Regional Water Board staff will coordinate monitoring activities to investigate other sources of mercury loads to Clear Lake. These investigations by USEPA and the Regional Water Board should reduce the uncertainty that currently exists regarding the annual load of total mercury to the lake, the contribution of each source to that load, and the degree to which those sources lead to methylmercury exposure to and mercury uptake by fish in the lake. This information should lead to more refined decisions about what additional steps are appropriate and feasible to achieve the applicable water quality criteria.

The sediment compliance goals for Oaks Arm will require USEPA to address both (1) the ongoing releases from the terrestrial mine site and (2) the load of total mercury that currently exists in the active lakebed sediment layer as a result of past releases. Potential options to control the ongoing releases of mercury from the terrestrial mine site include: remediation of onsite waste rock, tailings and ore piles to minimize the erosion of mercury contaminated sediments into the lake; diversion of surface water run-on away from waste piles and the inactive mine pit; control and containment or treatment of surface water runoff; control of groundwater flow into Clear Lake; and reduction of mercury flux from the mine waste piles into the atmosphere.

Meeting the load allocation for the lakebed sediment will require remediation of contaminated sediment. Potential options to address the mercury that currently exists in the lakebed as a result of past releases and is being remobilized may include dredging the contaminated sediment, capping with clean sediments, facilitating natural burial of highly contaminated sediments, or reducing the transport of highly contaminated sediments from the Oaks Arm into the rest of the lake. Monitoring to assess progress toward meeting the load reductions goals from Sulphur Bank Mercury Mine should be planned and conducted as part of specific remediation activities. Baselines for mercury loads from the various ongoing inputs from the mine site should be established in order to evaluate successes of the remediation activities.

In order to refine the load estimates from SBMM, the Regional Water Board recommends that USEPA determine the following information: mercury concentrations and sediment deposition rates for sediment cores collected near the mine site; characterization of porewater in sediments near the mine site to determine sources, magnitude and impacts of mercury-containing fluids/groundwater entering the lake; estimates of total surface water and groundwater fluxes of mercury from SBMM, including transport through the wetlands north of the site; and patterns of sediment transport and deposition within the lake.

If additional information reveals that reaching the 95% reduction in mercury loads from the terrestrial mine site is technically infeasible or cost prohibitive, or otherwise not technically justified, the Regional Water Board will consider internal adjustments to the SBMM load allocation. It may be possible to adjust the allocation among the terrestrial site and the contaminated sediments associated with the SBMM, provided the internal reallocation achieves the same overall reduction in loads from mine-related sources (terrestrial mine site and ongoing contributions from highly contaminated sediments). Any internal adjustment must achieve the sediment compliance goals in the east end of Oaks Arm.

Although USEPA is currently spending public funds to address the releases from the SBMM, the owner of SBMM is the party that is legally responsible for addressing the past, current and future releases from the SBMM and for developing implementation plans, implementing control activities that result in achievement of the load reduction, and performing monitoring to verify the load reduction.

*Tributaries and Surface Water Runoff*

Past and current loads of total mercury from the tributaries and direct surface water runoff are also a source of mercury loading to the lake and to the active sediment layer in the lakebed. This section excludes loads from surface water runoff associated with the SBMM because those are addressed separately above. The loads of total mercury from the tributaries and surface water runoff to Clear Lake should be reduced by 20% of existing levels. In an average water year, existing loads are estimated to be 18 kg/year. Loads range from 1 to 60 kg/year, depending upon water flow rates and other factors. The load allocation applies to tributary inputs as a whole, instead of to individual tributaries. Efforts should be focused on identifying and controlling inputs from hot spots. The U.S. Bureau of Land Management, U.S. Forest Service, other landowning agencies in the Clear Lake Basin, and Lake County shall submit plans for monitoring and implementation to achieve the necessary load reductions. The Regional Water Board will coordinate with the above named agencies and other interested parties to develop the monitoring and implementation plans. The purpose of the monitoring shall be to refine load estimates and identify potential hot spots of mercury loading from tributaries or direct surface runoff into Clear Lake. Hot spots may include erosion of soils with concentrations of mercury above the average for the rest of the tributary. If significant sources are identified, the Regional Water Board will coordinate with the agencies to develop and implement load reductions. The implementation plans shall include a summation of existing erosion control efforts and a discussion of feasibility and proposed actions to control loads from identified hot spots. The agencies will provide monitoring and implementation plans within five years after the effective date of this amendment and implement load reduction plans within five years thereafter. The goal is to complete the load reductions within ten years of implementation plan approval.

Regional Water Board staff will work with the Native American Tribes in the Clear Lake watershed on mercury reduction programs for the tributaries and surface water runoff. Staff will solicit the Tribe's participation in the development of monitoring and implementation plans.

*Wetlands*

The Regional Water Board is concerned about the potential for wetland areas to be significant sources of methylmercury. Loads and fate of methylmercury from wetlands that drain to Clear Lake are not fully understood. The potential for production of methylmercury should be assessed during the planning of any wetlands or floodplain restoration projects within the Clear Lake watershed. The Regional Water Board establishes a goal of no significant increases of methylmercury to Clear Lake resulting from such activities. As factors contributing to mercury methylation are better understood, the possible control of existing methylmercury production within tributary watersheds should be examined.

*Atmospheric Deposition*

Atmospheric loads of mercury originating outside of the Clear Lake watershed and depositing locally are minimal. Global and regional atmospheric inputs of mercury are not under the jurisdiction of the Regional Water Board. Acceptable loads of mercury from outside of the Clear Lake watershed and depositing from air onto the lake surface are established at the existing input rate, which is estimated to be 1 to 2 kg/year.

*Public Education*

An important component of the Clear Lake mercury strategy is public education. Until the effects of all mercury reduction efforts are reflected in fish tissue levels, the public needs to be continually informed about safe fish consumption levels. The Lake County Public Health Department will provide outreach and education to the community, emphasizing portions of the population that are at risk, such as pregnant women and children. Education efforts may include recommendations to eat smaller fish and species having lower mercury concentrations.

*Monitoring and Review*

The monitoring plan for Clear Lake will determine whether mercury loads have been reduced to meet sediment compliance goals and fish tissue objectives. Monitoring will include fish tissue, water and sediment sampling. The Regional Water Board will oversee the preparation of detailed monitoring plans and resources to conduct monitoring of sediment, water and fish to assess progress toward meeting the water quality objectives. Chapter V, Surveillance and Monitoring, provides details for monitoring in Clear Lake.

The Regional Water Board will review the progress toward meeting the fish tissue objectives for Clear Lake every five years. The review will be timed to coincide with the five-year review to be conducted by USEPA for the Record of Decision for the Sulphur Bank Mercury Mine Superfund Site. The Clear Lake mercury management strategy was developed with existing information. The Regional Water Board recognizes that there are uncertainties with the load estimates and the correlation between reductions in loads of total mercury, methylmercury uptake by biota, and fish tissue concentrations. Regional Water Board staff will consider any new data to refine load estimates and allocations from sources within the Clear Lake watershed. Estimates of existing loads from SBMM or the tributaries will be refined during the review process. If new data indicate that the linkage analysis or allocations will not result in attainment of the water quality objectives, or the load allocations require adjustment, this implementation plan will be amended.

## 2.5 Proposed Modifications to Basin Plan Chapter V (Surveillance and Monitoring)

# V. SURVEILLANCE AND MONITORING

This chapter describes the methods and programs that the Regional Water Board uses to acquire water quality information. Acquisition of data is a basic need of a water quality control program and is required by both the Clean Water Act and the Porter-Cologne Water Quality Control Act.

The Regional Water Board's surveillance and monitoring efforts include different types of sample collection and analysis. Surface water surveillance may involve analyses of water, sediment, or tissue samples and ground water surveillance often includes collection and analysis of soil samples. Soil, water, and sediment samples are analyzed via standard, EPA approved, laboratory methods. The Regional Water Board addresses quality assurance through bid specifications and individual sampling actions such as submittal of split, duplicate, or spiked samples and lab inspections.

Although surveillance and monitoring efforts have traditionally relied upon measurement of key chemical/physical parameters (e.g., metals, organic and inorganic compounds, bacteria, temperature, and dissolved oxygen) as indicators of water quality, there is increasing recognition that close approximation of water quality impacts requires the use of biological indicators. This is particularly true for regulation of toxic compounds in surface waters where standard physical/chemical measurement may be inadequate to indicate the wide range of substances and circumstances able to cause toxicity to aquatic organisms. The use of biological indicators to identify or measure toxic discharges is often referred to as biotoxicity testing. EPA has issued guidelines and technical support materials for biotoxicity testing. A key use of the method is to monitor for compliance with narrative water quality objectives or permit requirements that specify that there is to be no discharge of toxic materials in toxic amounts. The Regional Water Board will continue to use biotoxicity procedures and testing in its surveillance and monitoring program.

As discussed previously, the protection, attainment, and maintenance of beneficial uses occur as part of a continuing cycle of identifying beneficial use impairments, applying control measures, and assessing program effectiveness. The Regional Water Board surveillance and monitoring program provides for the collection, analysis, and distribution of the water quality data needed to sustain its control program. Under ideal circumstances, the Regional Water Board surveillance and monitoring progr am would produce information on the frequency, duration, source, extent, and severity of beneficial use impairments. In attempting to meet this goal, the Regional Water Board relies upon a variety of measures to obtain information. The current surveillance and monitoring program consists primarily of seven elements:

**Data Collected by Other Agencies**

The Regional Water Board relies on data collected by a variety of other agencies. For example, the Department of Water Resources (DWR) has an ongoing monitoring program in the Delta and the United States Geological Survey (USGS) and DWR conduct monitoring in some upstream rivers. The Department of Fish and Game, Fish and Wildlife Service, USGS, and Department of Health Services also conduct special studies and collect data.

**Regional Water Board and State Water Board Monitoring Programs**

The State Water Board manages its own Toxic Substances Monitoring (TSM) program to collect and analyze fish tissue for the presence of bioaccumulative chemicals. The Regional Water Board participates in the selection of sampling sites for its basins and annually is provided with a report of the testing results.

**Special Studies**

Intensive water quality studies provide detailed data to locate and evaluate violations of receiving water standards and to make waste load allocations. They usually involve localized, frequent and/or continuous sampling. These studies are specially designed to evaluate problems in potential water quality limited segments, areas of special biological significance or hydrologic units requiring sampling in addition to the routine collection efforts.

One such study is the *San Joaquin River Subsurface Agricultural Drainage Monitoring Program*. The program includes the following tasks:

1. The dischargers will monitor discharge points and receiving waters for constituents of concern and flow (discharge points and receiving water points).

2. The Regional Board will inspect discharge flow monitoring facilities and will continue its cooperative effort with dischargers to ensure the quality of laboratory results.

3. The Regional Board will, on a regular basis, inspect any facilities constructed to store or treat agricultural subsurface drainage.

4. The Regional Board will continue to maintain and update its information on agricultural subsurface drainage facilities in the Grassland watershed. Efforts at collecting basic data on all facilities, including flow estimates and water quality will continue.

5. The Regional Water Board, in cooperation with other agencies, will regularly assess water conservation achievements, cost of such efforts and drainage reduction effectiveness information. In addition, in cooperation with the programs of other agencies and local district managers, the Regional Board will gather information on irrigation practices, i.e., irrigation efficiency, pre-irrigation efficiency, excessive deep percolation and on seepage losses.

**Aerial Surveillance**

Low-altitude flights are conducted primarily to observe variations in field conditions, gather photographic records of discharges, and document variations in water quality.

**Self-Monitoring**

Self-monitoring reports are normally submitted by the discharger on a monthly or quarterly basis as required by the permit conditions. They are routinely reviewed by Regional Water Board staff.

**Compliance Monitoring**

Compliance monitoring determines permit compliance, validates self-monitoring reports, and provides support for enforcement actions. Discharger compliance monitoring and enforcement actions are the responsibility of the Regional Water Board staff.

**Complaint Investigation**

Complaints from the public or governmental agencies regarding the discharge of pollutants or creation of nuisance conditions are investigated and pertinent information collected.

**<u>Clear Lake Methylmercury</u>**

<u>The Regional Water Board will use the following criteria to determine compliance with the methylmercury fish tissue objectives in Clear Lake. Mercury will be measured in fish of the species and sizes consumed by humans and wildlife. The objectives are based on the average of methylmercury concentrations in muscle tissue of trophic level 3 and 4 fish. Because greater than 85% of total mercury in muscle tissue of fish of these sizes is methylmercury, analysis of muscle tissue for total mercury is acceptable for assessing compliance.</u>

<u>Fish from the following species will be collected and analyzed every ten years. The representative fish species for trophic level 4 shall be largemouth bass (total length 300-400 mm), catfish (total length 300 – 400 mm), brown bullhead (total length 300-400 mm), and crappie (total length 200-300 mm). The representative fish species for trophic level 3 shall be carp, hitch, Sacramento blackfish, black bullhead, and bluegill of all sizes; and brown bullhead and catfish of lengths less than the trophic level 4 lengths.</u>

<u>Fish tissue mercury concentrations are not expected to respond quickly to remediation activities at Sulphur Bank Mercury Mine, Clear Lake sediments, or the tributaries. Adult fish integrate methylmercury over a lifetime and load reduction efforts are not expected to be discernable for more than five years after remediation efforts. Therefore to assess remedial activities, part of the monitoring at Clear Lake will include indicator species, consisting of inland silversides and largemouth bass less than one year old, to be sampled every five years. Juveniles of these species will reflect recent exposure to methylmercury and can be indicators of mercury reduction efforts.</u>

<u>Average concentrations of methylmercury by trophic level should be determined in a combination of the identified species collected throughout Clear Lake. The number of fish collected to determine compliance with this objective will be based on the statistical variance within each species. The sample size will be determined by methods described in USEPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish or other statistical methods approved by the Executive Officer.</u>

<u>Total mercury in tributary sediment, lake sediment, and water will be monitored to determine whether loads have decreased. The water and sediment monitoring frequency will be every five years.</u>

# 3 BENEFICIAL USES AND EXISTING CONDITIONS

## 3.1 Clear Lake Beneficial Uses Cited in the Basin Plan

Both the federal Clean Water Act and the California Water Code (Porter-Cologne Water Quality Act) require identification and protection of beneficial uses. The beneficial uses designated in Table II-1 of the Water Quality Control Plan for the Sacramento and San Joaquin Basins (CVRWQCB, 1998) are intended to meet all applicable State and federal requirements. Table 1 lists the existing and potential beneficial uses of Clear Lake. Clear Lake provides water for domestic, municipal and agricultural uses within its watershed. It is also a source of agricultural, domestic and industrial waters downstream in the Cache Creek watershed. The beneficial uses that are impaired by mercury in Clear Lake are wildlife habitat and sport/recreational fishing. Elevated mercury levels in fish from Clear Lake pose a risk for humans and wildlife that consume fish taken from the lake.

Table 1. Existing and Potential Beneficial Uses of Clear Lake

| Beneficial Use | Status |
|---|---|
| Municipal and domestic supply (MUN) | Existing |
| Agriculture – irrigation and stock watering (AGR) | Existing |
| Recreation – contact (REC-1) and other non-contact (REC-2) | Existing (a) |
| Freshwater habitat (Warm) | Existing |
| Spawning (SPWN) – warm | Existing |
| Wildlife habitat (WILD) | Existing (a) |
| Freshwater habitat (Cold) | Potential |

(a) Beneficial uses impaired by mercury in Clear Lake (CVRWQCB, 1998).

## 3.2 Existing Conditions

### *3.2.1 Mercury in Fish Tissue*

In 1970, California Department of Health Services collected and analyzed two composite samples of largemouth bass and white catfish from Clear Lake. This analysis provided the first indication that fish from Clear Lake might contain excessive levels of mercury (CVRWQCB, 1985). The U.S. Food and Drug Administration (USFDA) analyzed additional fish-tissue samples in 1976 (CVRWQCB, 1985). The Toxic Substances Monitoring Program of the State Water Resources Control Board then collected and analyzed fish samples from 1980 to 1983 (Rasmussen, 1993). Fish tissue data collected through 1985 were summarized in a report by Regional Water Board staff (CVRWQCB, 1985) and in the recommended guidelines for consumption of Clear Lake fish (Stratton et al., 1987). Most data were reported for individual fish, although some data were reported for composite samples. Staff of the University of California, Davis (UC Davis) Clear Lake Environmental Research Center (CLERC) continued sampling for fish tissue analyses in the 1990s and in 2000 (Suchanek et al., 2000; Suchanek et al., 1997; Suchanek et al., 1993). These data provide a good baseline from which to evaluate future water quality improvements.

Concentrations of mercury in fish from Clear Lake are shown in Table 2. More detailed data are shown in Appendix A. Concentrations of methylmercury in Clear Lake fish currently average 0.2 mg/kg in trophic level 3 fish (includes bluegill and hitch) and 0.5 mg/kg in trophic level 4 fish (includes bass, catfish and crappie). Fish-eating (piscivorous, trophic level 4) fish accumulated the highest levels of mercury and concentrations generally increased with age and size of fish. Concentrations of mercury in fish are, in general, not significantly different between the arms of the lake (Suchanek et al., 1997). Analysis of juvenile largemouth bass and inland silversides caught in 1998 and 1999 showed no decline in mercury concentrations, as compared to 1970-1984 mercury concentrations (Suchanek et al., 2000). Concentrations in adult largemouth bass also show no decrease with time (Personal communication from T. Suchanek, September 2001).

Humans consume trophic level (TL) 3 and TL4 fish from Clear Lake (Harnly et al., 1997; Macedo, 1991). The most frequently consumed TL4 species are largemouth bass, channel and white catfish, and black crappie. The most frequently consumed TL3 species are bluegill, black bullhead, brown bullhead, carp, hitch, and Sacramento blackfish.

Table 2. Concentrations of Mercury Tissue Clear Lake Fish

| **Fish Species** | **Mercury Concentration (■g/g wet weight, ppm)** | |
|---|---|---|
| | Mean | Standard Deviation |
| Inland silverside | 0.09 | 0.03 |
| Largemouth bass, juvenile | 0.18 | 0.04 |
| Bluegill | 0.19 | 0.20 |
| Hitch | 0.19 | 0.13 |
| Carp | 0.20 | 0.17 |
| Black bullhead | 0.22 | 0.09 |
| Sacramento blackfish | 0.28 | 0.10 |
| Brown bullhead | 0.28 | 0.11 |
| Black crappie | 0.36 | 0.19 |
| White crappie | 0.48 | 0.36 |
| Channel catfish | 0.48 | 0.37 |
| White catfish | 0.51 | 0.18 |
| Largemouth bass, adults | 0.54 | 0.32 |

Sources: CVRWQCB, 1985; Suchanek et al., 1993; Suchanek et al., 1997

### *3.2.2 Data for Other Wildlife*

A complete ecological assessment of mercury effects has not been completed for Clear Lake. In particular, there is no information on potential sublethal, behavioral or reproductive effects of mercury on resident mammals or on fish-eating birds. However, some samples from birds, raccoons, minks, and crayfish have been analyzed for mercury. The results of these analyses are described below.

Mercury concentrations in tissue samples from grebes (CDFG, 1984d; CVRWQCB, 1985; Elbert and Anderson, 1998), herons (Elbert, 1996), and ospreys (Suchanek et al., 1997) from Clear Lake cohorts are elevated compared to mercury concentrations in tissue samples from cohorts in pristine areas. Nesting success of herons and cormorants (Wolfe and Norman, 1998) and ospreys (Suchanek et al., 1997) does not appear to be affected by mercury. However, the numbers of healthy offspring per nest of western grebes at Clear Lake were found to be significantly less than numbers at two other remote California lakes not contaminated by mercury (Elbert and Anderson, 1998). The authors concluded that nesting may be adversely impacted by mercury as well as other factors, such as human disturbance and boating.

Feathers were collected from nesting, fish-eating birds at Clear Lake in the early 1990s (Suchanek et al., 1997). Adult osprey showed the highest mercury values with an average of 20 ppm dry weight, with western grebes and great blue herons having much lower levels. A concentration of mercury in feathers of 20 ppm is considered a toxic risk level for birds (Scheuhammer, 1991).

Mercury has been measured in tissues of some mammals caught near the shores of Clear Lake (Wolfe and Norman, 1998). All raccoons and seven of eight mink examined had levels of mercury in brains and fur that were below no-observable effect levels reported in the literature. There are no field data available on reproductive effects of mercury in mammalian wildlife at Clear Lake.

A preliminary assessment of hazards to wildlife from mercury and arsenic at Clear Lake was prepared for the 1994 Remedial Investigation Report for Sulphur Bank Mercury Mine (Elbert, 1993). Mercury concentrations in tissues of Clear Lake wildlife were compared with tissue concentrations and effects in published literature. Elbert concluded that mercury concentrations in prey fish from Clear Lake are unlikely to cause lethality of top-trophic level wildlife species. Mercury concentrations in prey fish could be high enough to cause reduced hatching success and/or behavioral abnormalities and reduced survival of young. Mercury concentrations in adult wildlife could be enough to cause behavioral abnormalities such as reduced nest attendance, which can result in reduced reproductive success (Elbert, 1993).

### *3.2.3 Sediment and Water Data*

The lakebed sediment consists of an active surficial layer in which mixing, resuspension, deposition, chemical cycling and methylation occur. Below the active layer, mercury becomes buried and removed from the cycle. Baseline concentrations of mercury in surficial sediment of Lower and Upper Arms are obtained from sediment core samples collected in 1996 and 2000 (Appendices B and D). Average concentrations in surficial sediment are shown in Table 3. Mercury levels surficial sediments of Oaks Arm show a statistically significant decline as a function of distance from the SBMM. Baseline surficial sediment concentrations were provided by T. Suchanek of UC Davis from sediment data collected in 1996-1998.

Sediment concentrations prior to the start of mining at Sulphur Bank are also shown in Table 3. These are the average of concentrations in core sections of sediment deposited before 1850. Background sediment concentrations in Oaks Arm are higher than in the other Arms. Higher levels of mercury in deep Oaks Arm sediments relative to the other arms are not unexpected, given the presence of the hydrothermal system that formed the SBMM mercury deposit.

Table 3. Mercury in Clear Lake Sediments – Background and Existing Conditions

| Location | Distance from SBMM (km) | Mercury in surficial sediment (mg/kg dry weight) | |
|---|---|---|---|
| | | Existing Concentration | Pre-mining Concentration |
| Oaks Arm | | | |
| OA-01 | 0.3 | 209 | 12 est. (d) |
| OA-02 | 0.8 | 92 (a) | 10 est. (d) |
| OA-03 | 1.8 | 53 (a) | 8 (c) |
| OA-04 | 3 | 34 (a) | 6 est. (d) |
| The Narrows | 7.7 | 10 (a) | 2 est. (d) |
| Lower Arm | | 3.0 – 5. (b) | 0.5 – 2.0 (c) |
| Upper Arm | | 2.4 – 4.8 (b) | 0.2 – 0.3 (c) |

(a) Surficial sediment concentrations collected by UC Davis CLERC in 1996-1998. Data provided to Regional Water Board staff by T. Suchanek.
(b) Surficial sediment concentrations in core samples collected in 1996 and 2000. Suchanek et al., 1997 and Appendix B.
(c) Pre-mining (prior to 1850) concentration from core samples collected in 1996 and 2000 (Appendix D).
(d) Estimate concentration from core samples collected at site OA-03 in 1996 and 2000. Assumes a decline in concentration with distance from Sulphur Bank hydrothermal spring. See Appendix B.

Like the sediment samples, unfiltered water samples collected near the SBMM had the highest concentrations of mercury, with concentrations decreasing as a function of distance from the mine (Suchanek et al., 1997; Suchanek et al., 1993). The California Toxics Rule criterion for total recoverable mercury has been exceeded in Clear Lake. Of water samples collected every six weeks to quarterly from May 1994 through August 1996, 25% (29/114) of deep water samples and 11% (13/114) of surface water samples contained mercury concentrations greater than 50 ng/L. Most samples with levels above 50 ng/L were collected from Oaks Arm, with only three samples coming from the Narrows, one from Lower Arm and none from Upper Arm. Mercury in water samples from Oaks Arm ranged up to 400 ng/L (Suchanek et al., 1997). A database of several hundred records for total mercury in water collected from 1992 to 1998 (including the above data) lists additional exceedances in Oaks Arm. Of the additional samples collected at the other locations, only one sample exceeded 50 ng/L; that sample was collected from Lower Arm (Suchanek, 2000b).

Levels of mercury in filtered water (i.e., the dissolved fraction) average around 1.0 to 2.0 ng/L. A peak concentration of 8.7 ng/L was measured near the mine site in April 1996, following a winter of heavy rains and overflow of water from Herman Impoundment (Suchanek et al., 1997). Average concentrations of methylmercury were 0.05 - 0.1 ng/L in filtered and 0.1 – 0.2 ng/L in unfiltered water samples taken throughout the lake. The peak of methylmercury production occurred in late summer or fall and was reflected by methylmercury concentrations up to 0.7 ng/L in unfiltered samples (Suchanek et al., 1997).

### *3.2.4 Humans*

One study exists of human exposure to mercury at Clear Lake (Harnly et al., 1997). The 68 study participants included members of the Elem Indian Colony and neighbors of the SBMM site. The study showed that the participants consumed fish from the top and middle trophic levels. Asked to recall their consumption of local and commercial fish over the previous six months, some individuals reported consumption in excess of the Clear Lake fish advisory. Mercury levels in hair samples from study participants were less than levels linked with damage to unborn children. (See Appendix E for details of the study.)

### 3.3 Proposed Modification to Basin Plan for Existing and Potential Beneficial Uses to Include Commercial and Sport Fishing (COMM)

As noted in Section 3.1, Basin Plan Table II-1 lists the existing and potential uses of Clear Lake. The Basin Plan provides a standard definition for commercial and sport fishing (COMM). The COMM designation is defined as "uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes." (CVRWQCB, 1998). The current Basin Plan does not include the commercial and sport fishing (COMM) designation for Clear Lake.

Commercial and sport fishing is a past and present use of Clear Lake (Bairrington, 2000). The California Department of Fish and Game (CDFG) issues commercial fishing licenses for commercial harvest of Sacramento blackfish and carp for human consumption. Clear Lake also supports a significant sport fishery. It is often called the "Bass Capital of the West" for its excellent largemouth bass fishery. CDFG issues numerous sport fishing licenses and tournament permits for use in Clear Lake. Species caught and generally kept for consumption by sport anglers include white and channel catfish, sunfish, bullhead, crappie and some largemouth bass (Macedo, 1991). The warm water fishery supported by Clear Lake is an important segment of the economy of the Clear Lake basin. Adding the beneficial use designation COMM to Clear Lake would clarify the existing uses of the lake.

# 4 WATER QUALITY OBJECTIVES

Water quality objectives are established in Basin Plans by the California Regional Water Quality Boards to reasonably protect beneficial uses. Water quality objectives provide a specific basis for the measurement and maintenance of water quality.

The Basin Plan for the Sacramento and San Joaquin Rivers does not contain numeric water quality objectives for mercury. In this proposed Basin Plan amendment, site-specific numeric water quality objectives are considered for Clear Lake, Lake County.

Numerical guidelines and recommended criteria are available from USEPA and other agencies for the development of water quality objectives for mercury. These numerical guidelines were reviewed by Regional Water Board staff in preparing the alternatives listed below. Regional Water Board staff also wrote an extensive report on deriving numeric targets for mercury to protect wildlife and humans[1].

The USEPA promulgated the California Toxic Rule (CTR) in April 2000 (USEPA, 2000a). The CTR contains a water quality objective of 0.05 µg/L (50 ng/L) total recoverable mercury for freshwater sources of drinking water. The CTR criterion protects humans from exposure to mercury in drinking water and contaminated fish. The standard is enforceable for all waters with a municipal and domestic water supply and/or any aquatic beneficial use designation. The CTR criterion currently applies to Clear Lake and is discussed further under Section 4.3. The USEPA also released a recommended criterion for methylmercury in fish tissue, which is proposed as Alternative 2. The USEPA is considering adjustment of the 50 ng/L mercury criterion contained in the CTR and may release an amendment to the rule in 2003.

## 4.1 Alternatives Considered

Five alternatives were considered in developing water quality objectives for the regulation of methylmercury in fish at Clear Lake. These alternatives are: 1) no site-specific objectives for Clear Lake; 2) the adoption of USEPA's recommended water quality criterion for methylmercury; 3) the adoption of site-specific objectives based on a consumption rate by humans of 17.5 grams/day of locally-caught fish; 4) the adoption of site-specific objectives designed to protect endangered species at Clear Lake; and 5) the adoption of site-specific objectives based on traditional consumption by a local Native American tribe. Calculations for Alternative 2 are shown in the text below; calculations for the other alternatives are presented in Appendix C.

### *4.1.1 Alternative 1. No Action*

If no site-specific objectives are adopted for mercury in Clear Lake, the narrative objective of the Basin Plan still applies. The narrative water quality objective for toxicity in the Basin Plan states, in part, "All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life." The narrative toxicity objective further

[1] The final version of the *Clear Lake TMDL for Mercury Numeric Target Report* is available on the Regional Water Board's website: http://www.swrcb.ca.gov/rwqcb5/programs/tmdl/clearlake.htm. It is also an appendix to the *Clear Lake TMDL for Mercury Final Report.*

states that “The Regional Water Board will also consider … numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U.S. Food and Drug Administration, the National Academy of Sciences, the USEPA, and other appropriate organizations to evaluate compliance with this objective.” (CVRWQCB, 1998).

The following alternatives propose numerical water quality objectives that clarify the narrative objective and facilitate implementation of a water quality management strategy to reduce mercury in Clear Lake. Numeric objectives for Clear Lake are needed to assess progress in attaining the beneficial uses. In particular, the implementation plan proposed as part of the Basin Plan amendment is based upon numeric targets and quantitative reductions required to meet those goals.

#### *4.1.2 Alternative 2. Adoption of USEPA’s Recommended Water Quality Criterion for Methylmercury (0.3 mg/kg, wet weight)*

The USEPA recommends an ambient water quality criterion for methylmercury in the form of a concentration in fish tissue (USEPA, 2001a). The recommended criterion of 0.3 mg/kg mercury in fish tissue (wet weight) was established to protect human health. The USEPA criterion represents the concentration in fish tissue that should not be exceeded based on a total consumption of locally caught fish of 17.5 g/day[2]. A level of 17.5 g/day is the consumption rate reported by the 90$^{th}$ percentile of participants in a 1994-96 nation-wide food survey conducted by the U.S. Department of Agriculture (including people who do not eat fish). The 17.5 g/day rate is the sum of particular amounts of fish from trophic levels 2, 3, and 4[3]. The USEPA criterion assumes consumers also eat 12.5 g/day of fish obtained from commercial sources.

Other variables incorporated into the USEPA recommended criterion are an acceptable daily intake level of methylmercury (reference dose; RfD) of 0.1 micrograms/kg body weight/day and a standard adult body weight of 70 kg (NRC, 2000; USEPA, 2001a). The USEPA published this reference dose along with the recommended criterion in 2001. The reference dose was fully supported in an analysis of methylmercury data conducted by the National Research Council at the request of the U.S. Congress (NRC, 2000).

The USEPA criterion assumes consumers eat 12.5 g/day of fish obtained from commercial sources, in addition to the locally caught fish. USEPA estimates that the average methylmercury intake from eating 12 5g/day of commercial fish (mainly marine species) is 0.027 micrograms/kg bwt/day. The estimated intake of methylmercury from other sources, such as drinking water, other foods and air, is negligible (USEPA, 2001a). In order to calculate the fish tissue criterion for locally caught fish, the methylmercury dose from commercial fish was subtracted from the reference dose.

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2 17.5 g/day is equivalent to one eight-ounce meal per 2-week period, or four ounces per week (2.3 meals/month). 12.5 g/day is equivalent to 1.7 eight-ounce meals per month.

3 Trophic levels are the hierarchical strata of a food web characterized by organisms that are the same number of steps removed from the primary producers. The USEPA Mercury Study Report to Congress used the following criteria to designate trophic levels based on an organism’s feeding habits (USEPA 1997c):

Trophic level 1: Phytoplankton.
Trophic level 2: Zooplankton, benthic invertebrates, and fish that eat phytoplankton.
Trophic level 3: Organisms that consume zooplankton, benthic invertebrates and/or herbivorous fish.
Trophic level 4: Organisms that consume trophic level 3 organisms.

The water quality objectives proposed in Alternatives 2, 3 and 4 protect children as well as adults. Because calculation of the objectives includes a body weight term, children consuming an average portion of fish relative to their body size would be protected (USEPA, 2001a). A table relating body weight to portion size is available from the Office of Environmental Health Hazard Assessment (OEHHA, 1999).

*The following equation was used for calculation of USEPA's recommended methylmercury water quality criterion:*

$$\frac{(\text{RfD} - \text{intake from other sources}) * \text{body weight}}{(\text{CRate}_{TL2} + \text{CRate}_{TL3} + \text{CRate}_{TL4})} = \text{Acceptable level of mercury in fish}$$

| | | | |
|---|---|---|---|
| Where: | RfD | = | Reference dose for humans |
| | $\text{CRate}_{TL2}$ | = | Consumption rate of fish from Trophic Level 2 |
| | $\text{CRate}_{TL3}$ | = | Consumption rate of fish from Trophic Level 3 |
| | $\text{CRate}_{TL4}$ | = | Consumption rate of fish from Trophic Level 4 |

Application of USEPA's reference dose and default consumption rates to the above equation:

$$\frac{(0.10\ \mu g/kg\ day - 0.027\ \mu g/kg\ day) * 70\ kg}{(3.8\ g/day + 8.0\ g/day + 5.7\ g/day)} = 0.3\ \mu g\ \text{methylmercury/g fish tissue} (=0.3\ mg/kg)$$

As discussed in Section 4.1.3, some wildlife species are potentially at risk if they consume fish from tropic levels 3 and 4 from Clear Lake.

#### *4.1.3 Alternative 3. Adoption of Site-Specific Objectives Based on a Consumption Rate by Humans of 17.5 grams/day of Locally-Caught Fish (0.3 mg/kg, wet weight for trophic level 4 fish; 0.13 mg/kg wet wt for trophic level 3 fish)*

The basic methodology used to derive the USEPA recommended criterion was used to develop site-specific water quality objectives for Clear Lake. Instead of assuming the proportions of tropic level 2, 3 and 4 fish reported as the national average, the site-specific objectives assume proportions of trophic level 3 and 4 fish reportedly caught at Clear Lake. Clear Lake creel surveys suggest that consumers eat a higher percentage of fish from trophic level 4 and less fish from trophic level 2 than the national average (Cannata, 2000; Macedo, 1991). The consumption rate of locally caught fish for the 90$^{th}$ percentile of the local population (including non-consumers) was assumed to be 17.5 g/day, as shown nationwide in the 1993-94 USFDA study. Based on the Clear Lake creel surveys, consumers were assumed to eat a combination of species, 70% from trophic level 4 and 30% from trophic level 3. Consumers were assumed to also eat 12.5 g/day of commercial fish.

Other variables incorporated into the site-specific objectives are a reference dose of 0.1 micrograms/kg body weight/day and a body weight of 65 kg[4]. The body weight used is the standard for a pregnant female. This body weight was selected to acknowledge the particular sensitivity of unborn children to

[4] The bodyweight used by Regional Water Board staff to derive the objectives (65 kg; average for pregnant female) is slightly less than the bodyweight used by USEPA (70 kg; average for adult). Both are standard weights for adult humans used in criteria and risk assessment. Use of 70 kg would not change the objectives proposed in Alternatives 3, 4 or 5.

toxic effects of methylmercury (Grandjean et al., 1997; NRC, 2000). These water quality objectives also include a 5% safety factor to account for variation in consumption rates.

Application of site-specific fishery information results in the following objectives: 0.13 and 0.30 mg methylmercury/kg wet weight of fish tissue in trophic levels 3 and 4 fish, respectively. These targets apply to the average of methylmercury concentrations in each trophic level. In Clear Lake, trophic level 4 fish include largemouth bass, catfish and crappie. Trophic level 3 fish in Clear Lake include hitch, bluegill and Sacramento blackfish. See Appendix C for details of the calculations.

Alternative 3 objectives were derived to protect human health. Wildlife potentially at risk are piscivorous waterfowl, raptors and mammals. Reaching an objective of 0.3 mg/kg wet weight in trophic level 4 fish would reduce fish tissue concentrations in trophic level 2 and 3 fish, commonly consumed by wildlife such as grebes, mergansers, herons, and mink, to 0.09 mg/kg. Larger wildlife species, such as osprey, bald eagle and river otter, are expected to consume fish from trophic levels 3 and 4. In the original analysis presented in the draft Clear Lake TMDL Report, Regional Water Board staff indicated that most wildlife species at risk for mercury contamination at Clear Lake would be protected. Using literature values for consumption rates and body weights of various species, it was estimated that river otter and kingfisher would slightly exceed the respective safe daily intake levels of methylmercury for mammals and birds. No information is available on health of river otters or kingfishers at Clear Lake.

The U.S. Fish and Wildlife Service (USFWS) reviewed the draft Clear Lake TMDL Report and accompanying Clear Lake Numeric Target Report. The USFWS indicated that the assumptions made in the TMDL reports regarding prey items for bald eagle and osprey were too conservative and therefore inappropriate for accurately assessing risk. Using the USFWS recommendations for prey size and type, bald eagles (federally listed as threatened and State of California listed as endangered) and osprey would not be fully protected by water quality objectives of 0.3 and 0.13 mg/kg in trophic level 4 and 3 fish, respectively.

These water quality objectives do contain a margin of safety for wildlife that eat fish from Clear Lake. The avian and mammalian reference doses each contain an uncertainty factor of three. These uncertainty factors lower the reference doses below levels of mercury known to cause adverse effects to mallards and mink, respectively. Although the uncertainty factors were not originally applied to account for species differences, they do provide some measure of protection to wildlife that may be more sensitive to effects of mercury.

#### *4.1.4 Alternative 4. Adoption of Site-Specific Objectives Designed to Protect Humans and Endangered Species*

In their comments on the Clear Lake TMDL Report, the USFWS recommended water quality objectives that would be fully protective of wildlife at Clear Lake, including the federally listed bald eagle. The USFWS estimated methylmercury intakes by bald eagle and osprey consuming fish and, in the case of bald eagle, piscivorous birds, from Clear Lake. The USFWS recommended water quality objectives of 0.09 and 0.19 mg/kg methylmercury in trophic level 3 and 4 fish, respectively, to protect wildlife (USFWS, 2002). If these objectives were achieved, methylmercury intakes by other piscivorous wildlife, including river otter and belted kingfisher, would be expected to be at or below safe levels. Additional details on calculation of the safe intake levels of methylmercury by wildlife and comparisons with estimated intakes by wildlife consuming fish from Clear Lake are presented in Appendix C and supporting documents, the Clear Lake Numeric Target Report, and comments by USFWS.

Adult human consumption of fish with these water quality objectives correspond to a safe consumption rates of 26 g/day, if these consumers also eat the national average of 12.5 g/day of commercial fish. For consumers eating only fish from Clear Lake, 36 g/day could be safely consumed[5]. These consumption rates are similar to the rate reported by the 90th percentile of participants in a study of consumption and mercury exposure at Clear Lake, which was 30 g/day (Harnly et al., 1997). Study participants were sixty-four members of the Elem Pomo Tribe and several non-Tribal neighbors, all living on the shore of the lake. At least some participants ate commercial fish as well. Species from Clear Lake that were reported consumed in the greatest amounts were catfish and perch.

This alternative takes into account somewhat higher consumption patterns of Native American populations. Five Native American tribes utilize the Clear Lake fishery. Native Americans at Clear Lake report that their current levels of fish consumption are less than traditional levels, due to the fish consumption advisory for Clear Lake. Wildlife at Clear Lake are expected to be fully protected under these objectives.

Mercury is found in freshwater and marine fish and in commercial fish as well as locally caught fish. The tissue concentration for trophic level 4 fish, 0.19 mg/kg, is nearly equal to the average concentration in domestically processed, canned tuna fish (0.2 mg/kg) (USFDA, 1976). While Alternative 4 was not developed to coincide with the concentrations in a popular commercial fish, it demonstrates that fish from the grocery store contains mercury concentrations similar to those proposed in the Basin Plan amendment.

#### *4.1.5 Alternative 5. Adoption of Site-Specific Objectives Based on a Subsistence Consumption Rate*

Staff also developed Clear Lake-specific objectives using a consumption rate of 907 g/day. When traditional fish harvesting practices were followed, Native Americans at Clear Lake reportedly ate approximately two pounds of fish from Clear Lake per day, mainly hitch (Personal communication with Tribal representatives, 29 May 2002). This traditional consumption rate is an estimate and may be adjusted as more information is gathered from Tribal elders.

The Clear Lake fishery is a very important cultural and economic resource for Native Americans in the area. Currently, six federally recognized Tribes live in the Clear Lake basin. Ancestors of these Tribes utilized fish and other resources from the lake for thousands of years. Members of one tribe, the Elem Tribe of Southeastern Pomo Indians, lived on the shores of the lake for over 11,800 years. In addition to fish being a mainstay of the diet of resident Tribes, members of other Tribes traveled regularly to the lake to obtain fish.

Two pounds/day is equivalent to 907 g/day[6]. In order for local residents to safely consume 907 g/day of hitch, existing levels of methylmercury in hitch must be reduced by approximately 96%. Reduction by

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[5] 26 g/day is equivalent to 0.8 eight-ounce meals per week or 7 meals every two months.
36 g/day is equivalent to just over one eight-ounce meal per week (1.1 meals/week) or 4.8 meals per month. These rates also assume 70% of fish consumed is from trophic level four and the remainder from trophic level 3.

[6] 907 g/day is equivalent to 4 eight ounce meals per day or 28 meals per week.

96% from existing levels results in corresponding numeric targets of 0.02 mg/kg in trophic level 4 fish and 0.0076 mg/kg in trophic level 3 fish. Hitch is a trophic level 3 species.

Wildlife species that consume trophic level 3 and 4 fish are expected to be protected with this alternative.

## 4.2 Evaluation of Alternatives

The Water Code Section 13241 identifies six factors that must be addressed when evaluating a water quality objective. Factors to be considered are:

- Past, present and probable future beneficial uses of water;
- Environmental characteristics of the hydrographic unit under consideration; including the quality of water available thereto;
- Water quality conditions that could reasonably be achieved through the coordinated control of all factors that affect water quality in the area;
- Economic considerations;
- The need for developing housing within the region; and
- The need to develop and use recycled water.

The alternatives for water quality objectives are evaluated with respect to these factors in the first six subsections below. The alternatives are also evaluated with respect to applicable State and federal policies

### *4.2.1 Beneficial Uses*

The existing and potential beneficial uses of Clear Lake are listed in Table 1. Two existing beneficial uses, Recreation 1 and Wildlife Habitat, are considered as impaired due to mercury in Clear Lake. The proposed beneficial use designation of commercial and sport fishing is also impaired. The proposed water quality objectives and implementation plan of the Basin Plan amendment are intended to restore all of these beneficial uses to Clear Lake. Section 5 of this report presents an implementation plan that would eliminate the impairment due to mercury.

Each of the proposed alternatives would protect all existing and proposed beneficial uses of Clear Lake with respect to mercury contamination. Under Alternative 1, beneficial uses are protected by the narrative toxicity objective of the Basin Plan. However, the success of the implementation plan for reducing mercury in Clear Lake will be evaluated against a numeric water quality objective. Options for numeric objectives are described in Sections 4.1.2 through 4.1.5.

### *4.2.2 Environmental Characteristics of the Hydrographic Unit*

The environmental characteristics and existing conditions of Clear Lake are discussed in Sections 1 and 3 of this report, respectively. Water from Clear Lake is of relatively high quality. It is used for drinking water, irrigation, contact recreation, and habitat for warm water aquatic species, including providing for a significant fishery and resources for terrestrial wildlife. Clear Lake is considered impaired due to mercury in sediment, water and biota and to excess nutrients, which promoted noxious algal blooms. Erosion control efforts in the watershed and hydrologic conditions may have contributed to improved clarity and reduced algal blooms seen in recent years. More details of the watershed characteristics and existing water quality conditions are included in the TMDL Report (Appendix E).

The proposed Basin Plan amendment is designed to improve the water quality of Clear Lake by establishing numeric water quality objectives for mercury and defining an implementation plan to meet the objectives. Depending upon the remediation activities selected by the responsible parties, there may be temporary, localized adverse impacts on water quality of the lake during implementation. Possible effects of these types of activities, such as dredging, are discussed in Section 7. All of the proposed Alternatives would result in improvements to water quality of Clear Lake. Levels of improvement that would likely be reached are described in the next section.

#### *4.2.3 Water Quality Conditions That Could Reasonably Be Achieved*

The Basin Plan narrative toxicity objective (Alternative 1, No Action) describes the water quality conditions that should exist in Clear Lake. In order to prepare an implementation plan to achieve these conditions, the narrative objective is translated into a numeric objective. Water quality conditions expected under Alternatives 2-5, which interpret the narrative objective, are discussed below.

Alternatives 2 and 3 are similar with respect to the water quality conditions that would be achieved. Meeting these proposed water quality objectives would allow people to safely eat a moderate amount of fish from Clear Lake (17.5 g/day). This consumption rate assumes that most of the fish eaten will be trophic level 4 species. If consumers ate only trophic level 3 species, the safe intake rate would be around 50 g/day (1.5 meals/week). If consumers eat no commercial fish, the safe intake of Clear Lake fish can also be slightly higher (an added 5.5 to 13 g/day, depending upon relative concentrations of mercury in local and commercial fish)[7]. These are safe consumption levels for all adults eating fish from Clear Lake, including pregnant and nursing women. Children of any age could safely eat at these consumption rates when the meal size is adjusted to the child's body weight (OEHHA, 1999). Under the existing fish consumption advisory, women who are pregnant or may become pregnant, nursing mothers and children under age 6 are advised to eat no fish from Clear Lake.

To attain the objectives in Alternatives 2 and 3, mercury in surficial sediment of the lake would have to be reduced to half of existing concentrations (calculation includes a 10% safety factor). Mercury levels in highly contaminated portions of Oaks Arm would be reduced even further. This linkage analysis is described in Section 5 and the TMDL Report (Appendix E). The estimated time to attainment in all Arms of the lake is approximately 80 years, assuming that new inputs of mercury are significantly reduced. Concentrations of mercury in water would be expected to drop in proportion to the sediment

[7] The estimated average concentration of methylmercury in commercial fish and shellfish, weighted by proportions of the types consumed, is 0.157 mg/kg USEPA, 2001b. Water Quality Criterion for the Protection of Human Health: Methylmercury. Final Document. Washington, DC, U.S. Environmental Protection Agency, Office of Science and Technology, Office of Water. EPA-823-F-01-001. January. Mercury levels in most fish consumed from Clear Lake are higher than this average. Consuming 12.5 g/day of commercial fish with average concentration of 0.157 mg/kg results in a methylmercury intake of 0.027 micrograms/kg body weight per day. Assuming Alternative 3 objectives were met, an equivalent intake would be obtained by consuming 5.5 – 13 g/day of Clear Lake fish, depending upon species selected.

concentrations. Under these conditions, exceedances of the CTR criterion would not be expected to occur.

Under Alternative 4, consumers could safely eat 30 g/day of mainly trophic level 4 fish or 72 g/day of only trophic level 3 fish (2.5 meals/week) from Clear Lake (slightly less if commercial fish such as tuna are eaten as well). To meet these objectives, concentrations of mercury in surficial sediment would need to be reduced to 30% of existing conditions (includes a 10% safety factor). Section 5 describes a feasible alternative to implement these objectives, which consists of active remediation on the terrestrial mine site and highly contaminated sediments, and passive burial of sediments in the rest of the lake. The estimated time to attainment in all arms of the lake is approximately 100 years, assuming that new inputs of mercury are significantly reduced. The CTR criterion is not expected to be exceeded under Alternative 4.

Water quality objectives proposed in Alternative 5 would allow consumers to eat 907 g/day of trophic level 3 species. This consumption rate is based on likely traditional consumption rates of hitch by Native Americans prior to major agricultural and mining development in the watershed. The corresponding consumption rate for consumers eating only trophic level 4 fish from Clear Lake is 340 g/day (1.5 meals/day). These consumption rates represent a reduction in fish tissue concentrations by 96% of existing levels. Assuming a linear relationship between fish tissue and sediment concentrations, the surficial sediment concentrations in the lake would need to be reduced by 96%, or essentially to "background" or pre-mining levels. Dredging, sediment capping or other remediation activities designed to meet Alternative 5 objectives would likely be needed for the entire lakebed and would be very costly. Whether pre-mining concentrations of mercury in sediment and/or fish could actually be reached, even under a very long timeframe, is highly uncertain. While remediation activities result in reduction of mercury in fish and other environmental compartments, the endpoints are generally less than presumed pristine or background conditions (Turner and Southworth, 1999). Under Alternative 5, the CTR criterion is not expected to be exceeded.

A potential goal for cleanup in Clear Lake would be to return mercury levels in fish tissue to levels that occurred in the premining period, also referred to as background tissue concentrations. Regional Water Board staff considered providing this as an alternative, but was unable to determine what background fish tissue levels of mercury would have been. Premining sediment concentrations are fairly well known from deep sediment cores. The ecology of the lake, however, has changed considerably since industrialization of the Clear Lake basin, including changes in aquatic species, water clarity, wetland acreage, and erosion in the watershed (Moyle, 2002). It is unlikely that the linkage relationship between mercury in sediment and fish tissue in Clear Lake that exists today is the same as that in the premining period. Because precise background conditions and the linkage relationship are unknown, reliable estimates of premining fish tissue concentrations that could be used to set water quality objectives are not available.

Natural processes in the lake may improve water quality conditions beyond the site-specific water quality objective in the proposed Basin Plan Amendment. The implementation alternatives proposed in Section 5 depend upon a combination of active remediation and passive burial of contaminated sediment with clean sediment from the tributaries. Although remediation activities will be designed to achieve a particular level of cleanup, passive burial is expected to continue indefinitely and may reduce sediment and fish tissue concentrations beyond the remediation goals and corresponding fish tissue concentrations. If mercury levels in the fish fall below the recommended water quality objectives, the Basin Plan objectives may be amended again to reflect the improved water quality conditions and to prevent degradation.

It is likely, even if the water quality objectives proposed in Alternatives 2, 3 or 4 were achieved, that a fish consumption advisory would still be in effect for Clear Lake. The Office of Environmental Health Hazard Assessment currently uses a relatively high standard for determining whether a fish consumption advisory is necessary (safe consumption of at least 3 meals/week of fish, or 97 g/day, from the waterbody (OEHHA, 2000)). Meeting the objectives proposed in Alternative 5 would presumably cause the fish consumption advisory to be lifted.

### *4.2.4 Economic Considerations*

The Clear Lake fishery is an important part of the economy of the Clear Lake basin. The lake is a popular site for sport fishing. Known as the Bass Capitol of the West, at least 25 professional bass tournaments are held at Clear Lake yearly. Sport fish that are consumed from Clear Lake include catfish, bluegill, crappie, hitch and largemouth bass. Clear Lake also supports a limited commercial fishery for Sacramento blackfish and carp. From creel survey and commercial catch data gathered in 1993 and 1994, the California Department of Fish and Game estimated approximately 53,000 pounds of fish were removed from Clear Lake annually. This is likely a low estimate because few anglers fishing from the bank were included in the creel survey (CDFG, 1998). Commercial fishing accounted for less than half of total pounds of fish taken from Clear Lake.

The high levels of mercury in Clear Lake fish and the existence of the fish consumption advisory limit consumption of fish from Clear Lake. Because the bass tournaments are catch-and-release, many sport fish caught in Clear Lake are not used for human consumption. Presumably use of the lake as a food resource would increase if mercury levels in Clear Lake fish were reduced to safe levels. Regional Water Board staff received numerous reports from local agencies and businesses of the negative economic impacts of poor water quality in the lake, including the presence of mercury. Clear Lake was one of the first waterbodies in California to be identified as having high mercury levels. Awareness of the mercury problem at Clear Lake is therefore high among anglers and tourists, relative to waterbodies for which mercury contamination has only recently been identified.

Native Americans depend upon fish from the lake as an economic resource. As described under Alternative 5, fish from the lake was a primary protein source for resident Native Americans in the pre-industrial period. Until the early 1980s, some members of resident Tribes supported themselves or earned supplemental income by selling fish from the lake. When high mercury levels in fish were identified, Native Americans voluntarily stopped this practice due to ethical concerns about selling contaminated fish. In conversations with Regional Water Board staff, representatives of the resident Tribes expressed their strong desire to be able to resume consuming at high levels and selling fish from Clear Lake.

Alternative 3 provides a reasonable balance between protection of beneficial uses and economic impacts. Because the fish tissue concentrations are lower, attainment of objectives under Alternatives 4 and 5 would require more time and/or money than attainment of the Alternative 3 objectives. Economic costs of implementation would increase if more remediation activities were performed. Without extra remediation activities, the time to reach the objectives through a combination of remediation and natural sedimentation would be increased. Conversely, the negative economic impacts of mercury contamination are expected to persist as long as Clear Lake is considered impaired due to mercury.

### *4.2.5 Need for Housing*

None of the proposed water quality objectives would restrict the development of housing in the Clear Lake watershed.

### *4.2.6 Need to Develop and Use Recycled Water*

There are no present restrictions on recycling of water due to mercury. The intent of this proposed amendment is to improve water quality and reduce mercury levels in water of Clear Lake. The proposed objectives, therefore, are consistent with the need to develop and use recycled water. None of the alternatives considered would restrict the development or use of recycled water.

### *4.2.7 Consistency with Federal and State Laws and Policies*

Federal and State agencies have adopted water quality control policies and water quality control plans to which Regional Water Board actions must conform. The following section describes each of the policies that are applicable to the proposed Basin Plan amendment. It also discusses applicable Regional Water Board policies that are contained in the Basin Plan.

#### *4.2.7.1 Endangered Species Act*

Wildlife species most likely to be adversely affected by mercury are upper trophic level species that feed mainly on fish, such as otter, grebe, heron and bald eagle. The bald eagle is listed at threatened at the federal level. Bald eagles winter and nest in the Clear Lake basin (USFWS, 2002). No other piscivorous birds that occur at Clear Lake are categorized as threatened or endangered on the federal list. On the State of California endangered and threatened species list, the bald eagle is the only species that is of concern for mercury contamination at Clear Lake. Alternatives 4 and 5 for water quality objectives are expected to be fully protective of wildlife species at Clear Lake, including bald eagles. Alternative 4 objectives were provided by USFWS and are fish tissue concentrations derived specifically to protect bald eagle and osprey feeding at Clear Lake.

The purpose of this Basin Plan amendment is to restore the beneficial uses that are not currently being met, including the use of the lake as wildlife habitat. The implementation plan is designed to improve the water quality of Clear Lake with respect to mercury contamination. Endangered species are not expected to be adversely affected by any portion of this Basin Plan Amendment. Habitat for endangered species and other wildlife is expected to be improved by the water quality objectives and implementation program.

#### *4.2.7.2 Antidegradation*

Federal policies generally prohibit any discharges or other actions that would reduce the quality of surface water or groundwater. Text of the federal policies is contained in 40 CFR 131.12. Modifications of beneficial use designations and relaxation of water quality objectives must conform to the antidegradation policies. This proposed Basin Plan amendment would not change any listed beneficial use designations for Clear Lake. The amendment would add commercial and sport fishing (COMM) as an existing beneficial use. Adoption and approval of this amendment would establish the first water quality objectives for mercury in Clear Lake. The implementation plan is designed to improve, not reduce, water quality in Clear Lake.

### *4.2.7.3 State Water Board Policies*

*The State Policy for Water Quality Control*
This policy is the basis for the State Water Board to protect water quality through the implementation of water resources management programs. The proposed Basin Plan amendment is consistent with this policy in that it provides an implementation plan to reduce the level of mercury contamination in Clear Lake.

*State Water Board Resolution No. 68-16, Statement of Policy with Respect to Maintaining High Quality of Water in California*
This policy restricts the Regional Water Board and dischargers from reducing the quality of surface water or groundwater even though the reduction may still allow protection of the beneficial uses; the goal of the policy is to maintain high quality waters. A change in water quality is only allowed if it provides maximum benefit to the people of the State, does not unreasonably affect beneficial uses, and does not result in lower water quality prescribed in other plans or policies. The proposed Basin Plan amendment establishes a water quality objective for mercury in fish tissue. The proposed objective is designed to be protective of most of the humans that consume fish from Clear Lake and wildlife, including threatened and endangered species, that consume fish or other wildlife from Clear Lake.

*State Water Board Resolution No. 88-63, Sources of Drinking Water Policy*
This policy states that all waters of the State are to be protected as existing or potential sources of municipal and domestic supply water. The proposed Basin Plan amendment is consistent with this policy. Clear Lake is a source of drinking water and has the beneficial uses of municipal, domestic supply, and agriculture. There is no proposal to change these beneficial uses. The proposed water quality objective and implementation plan will further reduce mercury levels in drinking water.

*State Water Board Resolution No. 90-67, Pollutant Policy Document*
The Pollutant Policy Document requires, in part, that the Regional Water Board develop a mass emission strategy for limiting loads of heavy metals, among other pollutants, from entering the Delta. Because water from Clear Lake flows to Cache Creek, which in turn eventually flows into the Delta, this policy applies to Clear Lake. The Clear Lake TMDL report and this proposed amendment establish a plan for limiting the load (total mass) of mercury (a heavy metal) from entering Clear Lake and eventually the Delta. Therefore, the proposed amendment is consistent with this policy.

*State Water Board Resolution No. 92-49, Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304*
This resolution contains policies and procedures for Regional Water Board to follow for oversight of cleanup projects to ensure cleanup and abatement activities protect the high quality of surface and groundwater. In order to comply with the proposed water quality objective, the proposed Basin Plan amendment provides an implementation plan for dischargers to follow to reduce the mercury loading into Clear Lake. The plan requires mercury discharges from the Sulphur Bank mercury mine to be minimized and for mercury sources to tributaries to Clear Lake to be monitored and controlled.

Resolution No. 92-49 is relevant and applicable to mercury cleanup activities in the Clear Lake watershed.

*Nonpoint Source Management Plan*

This plan describes general management approaches to address nonpoint sources of pollution including voluntary implementation of best management practices, regulatory based encouragement of best management practices, and adopted effluent limits (through federal permits). The plan allows for the least stringent approach to be followed to protect water quality and requires more stringent measures if water quality objectives are not achieved. The proposed Basin Plan amendment to reduce mercury concentrations requires that the USEPA continue remedial activities at the Sulphur Bank Mercury Mine. For the nonpoint sources, including mercury hot spots in tributaries to Clear Lake, the approach will be for the Regional Water Board to work with the local, State, and federal agencies to develop and implement monitoring programs to identify the mercury hot spots. Best management practices will be the most likely method to reduce erosion of mercury contaminated soils into Clear Lake.

#### *4.2.7.4 Regional Water Board Policies*

*Urban Runoff*

This policy requires subregional municipal and industrial plans to assess the impact of urban runoff on receiving water quality and to consider abatement measures if problems exist. While there are no known sources of mercury from municipal and industrial runoff in the Clear Lake watershed, the proposed Basin Plan amendment requires the local, State, and federal agencies to assess their jurisdictional land for mercury sources and to develop reduction plans if necessary. Mercury discharges from the SBMM site will be assessed and controlled through the USEPA Superfund Program.

*Controllable Factors Policy*

This policy requires controllable water quality factors be implemented to prevent further degradation of water quality where objectives have been exceeded. Currently, the proposed water quality objectives are being exceeded in Clear Lake. The proposed amendments include an implementation plan to control mercury discharges from the mine site and tributary hot spots. Compliance with the Basin Plan will prevent further degradation and improve water quality and is consistent with this policy.

*The Water Quality Limited Segment Policy*

This policy requires additional treatment beyond minimum federal requirements on discharges to Water Quality Limited Segments. The policy states that dischargers will be allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. The TMDL for mercury in Clear Lake established the total maximum load that can be applied to Clear Lake and still meet beneficial uses. The TMDL determined the load reductions required from each source and allocated those loads to the SBMM and to tributary watersheds to Clear Lake. The proposed Basin Plan amendment assigns load reductions to the mercury sources to meet water quality objectives and is consistent with this policy.

*Antidegradation Implementation Policy*

This policy requires the Regional Water Board to apply and implement State Water Board Resolution No. 68-16 when regulating discharges of pollutants. The Regional Water Board policy requires an assessment of the discharge that could affect waters of the State and to apply methods of best practicable treatment or control to maintain high quality water. As noted above, the proposed Basin Plan amendment includes water quality objective and an implementation plan to reduce mercury levels in Clear Lake water and fish tissue. The plan requires load reductions from the various mercury sources. The load reduction program may be accomplished through treatment and control measures designed to minimize or prevent release of mercury from sources.

*Policy for Application of Water Quality Objectives*
This policy in part defines water quality objectives, specifies that objectives may be narrative or numeric, and indicates that the objectives apply to all waters for which beneficial uses have been defined. The policy also discusses mixing zones and the use of NPDES permits to establish effluent limits and time schedules for compliance. It also requires the Regional Water Board to adopt numerical objectives on a site specific basis for constituents where compliance with narrative objectives is required. The proposed numeric objectives in this Basin Plan amendment are specific to surface waters in Clear Lake and will be used to determine compliance with the narrative standard. The proposed Basin Plan amendment does not propose to establish NPDES permits for the sources of mercury (tributary watersheds and the SBMM). However, the proposed amendment provide a time schedule for the local, State, and federal agencies to develop a time monitoring plans and it requires USEPA Superfund to develop and implement remediation plans for the Sulphur Bank Mercury Mine within ten years.

This policy states that the numeric water quality objectives must protect beneficial uses; however, the water quality objectives do not require improvement over naturally occurring background concentrations. As discussed in previous sections, the Clear Lake watershed is naturally enriched in mercury. Deep sediment core samples from the lake indicate that while mining activity has greatly increased mercury concentrations in lakebed sediment, there may have been elevated levels of mercury in the lake prior to mining. It is currently unknown what background concentrations of mercury may have been present in fish tissue. The proposed implementation plan will minimize mercury inputs from the mine and reduce tributary loading; in the long term, these actions should lower mercury concentrations in sediment and fish tissue to premining or background levels.

## 4.3 Recommended Alternative

Regional Water Board staff recommends adoption of Alternative 4, the Clear Lake-specific objectives of 0.09 mg/kg and 0.19 mg/kg methylmercury in wet weight fish tissue, for the average fish of trophic levels 3 and 4, respectively. These objectives were derived to be protective of wildlife at Clear Lake including bald eagles, which are federally-listed as threatened. These proposed objectives would allow humans to safely eat just under one meal per week of a combination of trophic level 3 and 4 fish from Clear Lake. Consumption could be slightly more, if only Clear Lake trophic level 3 fish are eaten or no methylmercury is obtained in commercial fish. These proposed objectives protect a higher proportion of the fish-consuming population than would be protected by Alternatives 2 and 3, which are based on USEPA's default consumption rate for the general population.

Alternative 1 is not recommended by Regional Water Board staff for two reasons. First, the USFWS and U.S. National Marine Fisheries Service are concerned that the USEPA's mercury objective in the CTR would not be sufficiently protective of threatened and endangered species. In addition, Regional Water Board staff is concerned that the CTR criterion is not sufficiently protective of humans that consume fish from Clear Lake. The CTR water column criterion was derived using the same factors as the fish tissue alternatives, with an additional factor to relate fish tissue concentrations to water concentrations. This additional factor, termed the practical bioconcentration factor, is the ratio of mercury concentrations in fish and water. The practical bioconcentration factor used for the CTR criterion is 7342.6 (USEPA, 2000a). In comparison, ratios of mercury in fish to water at Clear Lake are higher. Ratios of mercury in fish to total mercury in water at Clear Lake range from 9500 for hitch to 560,000 for largemouth bass (Suchanek et al., 1997). Use of the higher ratios would result in a lower water column criterion to protect humans at Clear Lake.

Alternatives 2 and 3 are not recommended because they have been determined by USFWS to be insufficiently protective of wildlife at Clear Lake. The USFWS determined that fish tissue concentrations of 0.3 mg/kg in trophic level 4 fish would still leave bald eagle, osprey and possibly river otter at risk for adverse effects of mercury. Site-specific consumption patterns or information on species' sensitivities to mercury are not available for most waterbodies, including Clear Lake. The USFWS assessment of risk is based upon the use of standard, literature values for average consumption by these wildlife species (USEPA, 1995 and 1997; USFWS, 2002). Although site-specific consumption information would be preferred, the use of average consumption patterns, sensitivities and body weight data is widely accepted for establishing water quality criteria for mercury and other pollutants, to protect humans and wildlife.

Another justification for not recommending Alternative 2 is that the USEPA recommended criterion is more difficult to apply than the proposed site-specific objectives. The USEPA criterion describes a level of methylmercury in fish tissue that should not be exceeded by an adult eating 17.5 g/day of locally-caught fish. Based on the national food survey data, people eat a combination of fish from trophic levels 2, 3 and 4, which will likely contain varying concentrations of methylmercury. The single-value USEPA criterion is essentially a weighted average concentration in fish tissue, which is weighted by consumption rates from each trophic level. Target concentrations of methylmercury concentrations in trophic level 4 fish, for example, could range between 0.35 to 0.68 mg/kg, and still result in an average concentration of 0.3 mg/kg, depending upon methylmercury concentrations in fish from trophic levels 2 and 3. The USEPA criterion is therefore difficult to interpret for determining compliance with water quality objectives.

Alternative 5 is not recommended at this time. "Background" levels of mercury in fish prior to the opening of SBMM are unknown. Whether two pounds per day of Clear Lake fish could ever have been eaten without any adverse effects of mercury is also unknown. With more area of shoreline wetlands and possibly a less eutrophic lake, it is conceivable that more methylmercury was available for uptake into fish prior to industrialization of the basin than is available today.

The consumption survey of members of the Elem Pomo Tribe and a few neighbors is the only study available that is specific to Clear Lake. The study did not attempt to identify consumption rates for the general population at Clear Lake. Average consumption rates of Clear Lake fish were influenced by the high consumption rates of several individuals. This study is very important because it shows that a high-consuming population exists at Clear Lake. The implementation plan includes public outreach to convey risk information to high-consuming individuals. Public outreach will also be planned to educate consumers about increasing the safe consumption rate by eating small or low trophic level fish.

An ultimate goal of mercury control in Clear Lake is to reduce levels in fish, such that greater amounts of fish can be safely consumed. As described in the proposed implementation plan described in Section 5, existing sediments are expected to be buried under cleaner sediment from the tributaries and direct runoff into the lake. Provided that past and ongoing contributions from SBMM are controlled, this burial of contaminated sediment is expected to eventually result in surficial sediment concentrations in the lakebed that are less than sediment concentrations needed to reach the Alternative 4 objectives. Presumably as sediment concentrations approach pre-mining concentrations, fish tissue levels will drop below the Alternative 4 objectives. However, the ultimate fish tissue concentrations and the length of time needed to reach them are uncertain. "Background" levels of mercury in fish prior to the opening of SBMM are unknown. Detectable levels of mercury are found in sediment corresponding to the pre-mining period, with concentrations up to 25 mg/kg in the eastern end of Oaks Arm (Suchanek et al., 1997). Whether two pounds per day of Clear Lake fish could ever have been eaten without any adverse effects of mercury (Alternative 5) is also unknown. The staff recommendation is to maintain the present recommended fish tissue target and require that abatement activities be implemented that would result in load reductions that would, over the long term, result in mercury fish tissue levels that would approach historical background levels.

### 4.4 Application of Recommended Alternative to the Basin Plan

The recommended alternative is contained in the proposed change to Chapter 3 of the Basin Plan. Adoption of the proposed change would establish site-specific water quality objectives for methylmercury in fish of trophic levels 3 and 4. To facilitate evaluating compliance with the proposed objectives, Chapter 5 of the Basin Plan (Surveillance and Monitoring) is proposed to be amended to include a monitoring program that specifies fish sizes as well as species within each trophic level. The fish sizes were derived from sizes of fish typically caught in Clear Lake (Macedo, 1991) and information on the life history and prey types of the various species of fish (McGinnis, 1984; Wang, 1986) and piscivorous wildlife (Hamas, 1994; USEPA, 1995; USEPA, 1997; USFWS, 2002). The minimum size for largemouth bass is the minimum length for a legal catch as determined by California Department of Fish and Game.

The objective for trophic level 4 fish is the average concentration in a combination of the following species: largemouth bass (total length 300-400 mm); catfish (total length 300-400 mm); brown bullhead (total length 300-400 mm); and crappie (total length 200-300 mm). Species of catfish found in Clear Lake are channel and white; species of crappie in the lake are white and black (Macedo, 1991). The objective for trophic level 3 fish is the average concentration in a combination of the following species: carp, hitch, Sacramento blackfish, black bullhead, bluegill of all sizes; and brown bullhead and catfish of lengths less than the size range for the trophic level 4 classification. A combination of the identified species should be collected from all arms of Clear Lake.

The Regional Water Board will act as the lead agency in developing detailed monitoring plans and obtaining resources to evaluate compliance with the proposed water quality objectives. Staff recommends that average concentrations of methylmercury should be calculated from the mercury concentrations in a statistically significant number of fish, as described in the monitoring section of this report. Sample sizes will be determined by applying USEPA's Guidance for Assessing Chemical Contaminant Data in Fish (USEPA, 2000b) or by other methods approved by the Executive Officer of the Regional Water Board. Section 6 of this report provides additional details on the surveillance and monitoring program to assess compliance with the water quality objectives.

# 5 PROGRAM OF IMPLEMENTATION

The proposed water quality objectives for mercury in Clear Lake are being exceeded. The Regional Water Board must therefore develop an implementation plan to bring Clear Lake into compliance with the proposed objectives in order to protect beneficial uses. Water Code Section 13242 prescribes the necessary contents of an implementation plan, which includes: 1) a description of the nature of the actions that are necessary to achieve the water quality objectives; 2) a time schedule; and 3) a monitoring and surveillance program. This section describes sources of mercury in Clear Lake, the linkage between loads of inorganic mercury and methylmercury in fish tissue, and the load reductions needed to meet the proposed water quality objectives. The section continues with an evaluation of alternative programs of implementation and the recommended alternatives. This evaluation is followed by the proposed implementation plan including time schedules. The estimated costs are presented as part of the evaluation of alternatives and are in Table 8. The surveillance and monitoring program is described in Section 6 of this report.

## 5.1 Sources of Mercury in Clear Lake

Inorganic mercury loads entering Clear Lake come from the following sources: groundwater and surface water from the SBMM site; tributaries and other surface water that flows directly into the lake; and atmospheric deposition, including atmospheric flux from SBMM. Some mercury deposited historically in the lake due to mine operations or erosion at SBMM may also contribute to mercury concentrations in fish today. The main outputs of mercury are: flux to the atmosphere from the lake surface; Cache Creek downstream flow; and burial in sediment. The lakebed sediment consists of an active surficial layer in which mixing, resuspension, deposition, chemical cycling and methylation occur. Below the active layer, mercury becomes buried and removed from the cycle.

The focus of the implementation plan is to reduce mercury in the active layer of lakebed sediment. The active layer contains mercury that is available for transformation into methylmercury and uptake into biota. Details regarding the mercury load estimates are provided in Section 3 of the TMDL Report (see Appendix E).

### *5.1.1 Sulphur Bank Mercury Mine*

#### *5.1.1.1 Site History*

SBMM is currently owned by Bradley Mining Company. In 1983, USEPA received requests from the Regional Water Board and the Elem Colony of Southeastern Pomo Native Americans to put SBMM on the National Priorities List. USEPA named SBMM to the Superfund National Priorities List in August 1990. USEPA identified Bradley Mining Company as a potentially responsible party for SBMM.

Since the 1950s, the Regional Water Board has been involved in the regulation and permitting of surface water discharges from the mine. The Regional Water Board issued waste discharge requirements in 1990 that prohibited the discharge of wastes from Herman Impoundment to Clear Lake and discharge of waste rock and tailings into Clear Lake. The waste discharge requirements required erosion control measures and monitoring to be conducted. Bradley Mining Company funded some investigations at the site and design of erosion control measures, but in 1991, informed USEPA and the Regional Water Board that it lacked sufficient funds to complete construction. At that time, USEPA assumed control of response actions at the site (USEPA, 1994). The Regional Water Board was the lead enforcement agency for SBMM until it became a Superfund site.

USEPA has completed multiple emergency response activities on the site in order to: control erosion from shore line waste rock piles; remove waste rock from wetlands; remove and replace contaminated soil from homes on the Elem Tribal Rancheria; and install surface water control systems to divert surface water from waste rock piles and Herman Impoundment.

From the early 1990s to the present, USEPA has also funded and directed a variety of research projects to characterize the site. In 1994, USEPA issued a Remedial Investigation/Feasibility Study Report that addressed mercury in surface water and waste rock (USEPA, 1994). Later research funded by USEPA revealed the significance of groundwater and atmospheric routes, as well as surface water, in transporting mercury from the mine site into Clear Lake (Suchanek et al., 1997; Suchanek et al., 2001a; Tetra Tech EMI, 2001; USEPA, 2001b). The USEPA then reopened its remedial investigation of SBMM to address groundwater and atmospheric routes of mercury movement.

##### *5.1.1.2 Site Description*

The Sulphur Bank Mercury Mine site covers approximately one square mile. It abuts the east shore of the Oaks Arm of Clear Lake. The site contains approximately 120 acres of exposed mine overburden and tailings (hereafter referred to as waste rock). Two small, unprocessed ore piles are also on the site (USEPA, 1994). Mercury in samples of mine materials ranged from 50 to 4,000 ppm (USEPA, 2001b). All piles of mine materials exhibit the potential to generate acid rock drainage (USEPA, 2001b). The abandoned mine pit, called Herman Impoundment, is filled with acidic water (pH 3) to a depth of 90 feet and has a surface area of about 20 acres. The average mercury concentrations in Herman Impoundment water and sediment are around 0.8 µg/L (ppb) and 26 mg/kg (ppm), respectively (Columbia Geoscience, 1988; USEPA, 1994). A geothermal vent located at the bottom of Herman Impoundment continues to discharge gases, minerals (including mercury) and fluids into the pit (White and Roberson, 1962).

A large pile of waste rock, known as the waste rock dam (WRD), stretches about 2,000 feet along the shore on the western side of the SBMM site. The WRD lies between Herman Impoundment and Clear Lake. The water surface of Herman Impoundment is 10-14 feet above the surface of Clear Lake, which creates a gradient of groundwater flow toward the lake. The northern side of the site is bounded by a wetland that drains to Clear Lake. Surface runoff from the northern waste rock piles is directed through culverts into the northern wetland. In 1990, rock and geofabric barriers were installed at the culverts to reduce transport of suspended solids. The northern wetland is used for cattle grazing and as a source of fish, tules, and other resources utilized by members of the Elem Pomo Tribe. Waste rock piles extend into the wetlands.

The SBMM is clearly the largest historical source of mercury now residing in lakebed sediments (Chamberlin et al., 1990; Suchanek et al., 1997). In samples collected in 1994-96 near the shore of SBMM, mercury concentrations in the sediment averaged 238 mg/kg with a range of 42–425 mg/kg (Suchanek et al., 1997). Surficial sediment samples show an exponential decline in mercury concentrations correlated with distance from the mine (Suchanek et al., 1997; see Appendix D of the

TMDL Report). Deep sediment cores from all arms of the lake show significant increases in sediment mercury concentrations around 1927, near the beginning of open pit operations (Suchanek et al., 1997 and Appendix E). Open-pit mining methods utilized heavy earth-moving equipment, which greatly increased erosion of mining materials. During mining operations, excavated overburden and tailings from on-site ore processing were disposed in piles on the mine site, along the Clear Lake shoreline, and directly in Clear Lake (USEPA, 1994). Mercury-containing material continued to erode from steeply sloped shoreline waste piles until USEPA remediated the WRD in 1992.

##### *5.1.1.3 Inputs of Mercury from SBMM*

Mercury from the SBMM site continues to enter Clear Lake through groundwater, surface erosion, and possibly atmospheric routes (Suchanek et al., 1997; Tetra Tech EMI, 2001). A major route of transport is through groundwater into the lake. The USEPA estimates that 1-2.5 kg of mercury fluxes through the WRD annually.

Mercury in the active lakebed sediment layer may also derive from remobilization of mercury deposited in the past due to mine-related processes. Although much of the mercury deposited previously from SBMM has likely been buried, currents and bioturbation may make some of this mercury available for methylation and uptake into biota. The extent of remobilization of the previously deposited material is unknown. Sediment cores should be collected in Oaks Arm near the mine. Analysis of these cores would establish concentrations of mercury over time and sedimentation rates in the areas most affected by mass erosion and dumping of waste rock from the mine site.

Inputs of mercury from SBMM are estimated to be between 1 and 568 kg/year. USEPA's estimate of mercury transported in groundwater from the WRD is used as the lower bound of mercury inputs from SBMM (Tetra Tech EMI, 2001; USEPA, 2001b). The USEPA is continuing investigations at the site and has thus far estimated inputs of mercury to Clear Lake only through groundwater in the WRD. Regional Water Board staff estimates that 568 kg/year is the maximum upper bound of all inputs from SBMM, including past and continuing contributions to the active sediment layer. This upper bound is an indirect measure of loads and was determined as the total amount of mercury deposited to surficial sediment annually, minus other inputs (See TMDL report, referenced in Appendix E). The lower and upper bounds of mercury inputs from SBMM were derived through different methods and are not directly comparable.

The USEPA anticipates that its further investigations at SBMM will provide data to reduce uncertainties and narrow the range of estimated loads from SBMM. USEPA's studies include measuring levels of mercury fluxed into the air from mine waste piles and estimating local deposition of the air-borne mercury. The USEPA is also continuing to examine mercury transported through wetlands north of the mine site. The Regional Water Board will accept refinements of existing loads during regular reviews of the implementation plan. Because the load allocations for SBMM are a percentage of existing loads, existing inputs may be refined without changing the Basin Plan. In contrast, if new data indicate that the load allocations in this Basin Plan amendment will not meet water quality objectives (i.e., the linkage analysis is inaccurate), the Basin Plan will be amended again.

Groundwater from SBMM appears to contribute mercury that is readily methylated, relative to mercury from other inputs. Groundwater flow from the mine site has been detected entering Clear Lake by subsurface flow through lake sediments (Shipp, 2001). Mercury in groundwater from the WRD is solubilized (Tetra Tech EMI, 2001) and likely in chemical forms that are easily taken up by methylating bacteria. Acidic drainage from the mine site also contains high sulfate concentrations (Shipp, 2001), which enhance the rates of methylation by sulfate-reducing bacteria (Rytuba, 2000). This assertion is supported by data showing that methylation rates near the mine are significantly higher than in other parts of Clear Lake (Suchanek, 2001b). Hydrodynamic modeling of currents and particle movement in the lake demonstrates that particles formed near the mine site can be carried relatively rapidly into other arms of Clear Lake (Rueda, 2001a). In contrast to mercury in SBMM groundwater, mercury in lakebed and tributary sediments originates primarily as cinnabar, which has low solubility in water.

### *5.1.2 Other Mercury Inputs*

Mercury entering Clear Lake from its tributaries originates in runoff from naturally mercury-enriched soils, sites of historical mining activities, and mercury deposited in the watershed from the atmosphere. Geothermal springs may contribute to tributary loads, particularly in the Schindler Creek tributary to Oaks Arm. Tributary and watershed runoff loads of total mercury range from 1 to 60 kg/year, depending upon flow rates. Loads in average water years are 18 kg/year. Mercury concentration data for these estimates were collected from three main tributaries during five different flow events in 1998-2001 (See Appendix E). Regression equations relating mercury concentration and flow were used to determine mercury loads over a 10 year period, including low and high water years, for these three tributaries with flow gages. Loads in the gauged tributaries were then extrapolated over the ungauged portion of the watershed.

Small amounts of mercury deposit directly on the surface of Clear Lake from the global atmospheric pool and potentially from local, mercury enriched sources. Atmospheric loads to the lake surface from the global pool were estimated using data from monitoring stations in Mendocino County and San Jose. Estimates ranged from 0.6 to 2.0 kg/year. These estimates are based on data from the National Mercury Deposition Network (Sweet, 2000) and San Francisco Bay (SFEI, 2001b).

Geothermal springs and lava tubes that discharge directly in the lake do not appear to be significant sources of mercury to Clear Lake. Mercury concentrations in surficial sediment samples collected near lakebed geothermal springs were not elevated, relative to levels in sediment away from geothermal springs (Suchanek et al., 1997).

### *5.1.3 Outputs of Mercury from Clear Lake*

Mercury is removed from active cycling in flow downstream to Cache Creek, in water extracted for municipal and agricultural uses, in biota removed from the lake for human and wildlife consumption, through flux to the atmosphere, and by deep burial in lakebed sediment. Burial is the most significant route of mercury removal from the system. An average of 5 kg of mercury is estimated to be removed from Clear Lake annually through the outputs other than sediment burial (See Appendix E for details).

## 5.2 Sources of Methylmercury

Methylmercury is produced primarily in surficial sediment by bacteria. Methylmercury in sediment cycles between methylation and demethylation and between flux to the water column and deposition. Methylmercury also enters Clear Lake from the tributaries. Estimates of methylmercury inputs and outputs are given in the TMDL report referenced in Appendix E. These estimates are highly uncertain, particularly in methylmercury flux from lakebed sediment. Tributary loads were estimated using methylmercury concentrations measured at stream gages, which are well upstream of tributary mouths. The fate of methylmercury produced upstream is unknown.

Regional Water Board staff is concerned about the possible effects of methylmercury that is produced in the tributaries on methylmercury bioaccumulation in Clear Lake. During the implementation plan five-year review and as the scientific understanding of methylation increases, Regional Water Board staff will consider potential ways of limiting production of methylmercury in the tributaries.

## 5.3 Linkage Between Mercury Loads and Mercury Levels in Fish Tissue

A linkage analysis describes the association of numeric water quality objectives with identified sources of mercury. Key steps in the linkage are the relationship between methylmercury in fish tissue and methylmercury in the water column and the association between methylmercury and total mercury in the sediment. A conceptual model of mercury loading and transformation is presented in Figure 2.

Regional Water Board staff assumes that there is a directly proportional relationship between methylmercury in fish and total mercury in the surficial sediment. This is admittedly a simplification of a highly complex process. Many factors affect methylation or concentrations of methylmercury, including sulfide and sulfate concentrations, temperature, organic carbon, concentrations of methylating and demethylating bacteria, rate of demethylation, chemical form of mercury, sunlight, pH, sediment grain size, and other nutrients (Barkay et al., 1997; Morel, 1998; Regnell et al., 1998; Xun et al., 1987). Factors that affect accumulation of methylmercury in fish tissue include species, growth rate, prey availability and preference, methylmercury intake by prey, and concentration of algae in the water column (Harris and Bodaly, 1998; Wiener and Spry, 1996; Pickhardt, 2002). To reduce levels of methylmercury in fish, however, loads of mercury to the lake must be reduced. Section 5.3.1 provides examples of remediation projects that demonstrate removal of inorganic mercury from a range of aquatic environments has been effective in reducing concentrations of mercury in fish.

The assumption of a directly proportional relationship between mercury in fish and in surficial sediment in Clear Lake is the result of a set of first order relationships, each controlled by a single variable of concentration of mercury or methylmercury. Concentrations of methylmercury in water and methylmercury in biota are related by bioaccumulation factors (BAFs). Relationships between methylmercury in the water column and in sediment can be described as a flux rate of methylmercury from sediment. Concentrations of methylmercury and total mercury in sediment are related through calculation of a methylation efficiency index (ratio of methylmercury to total mercury in surficial sediment).

In each of these steps in the linkage analysis, one variable is related to another by a simple ratio or linear equation. For example, BAFs are calculated by dividing the concentration of methylmercury in fish by the concentration of methylmercury in the water. Data are available to determine BAF and methylation indices that are specific to Clear Lake. With current understanding of the transport, methylation and uptake processes in Clear Lake, staff is unable to refine these relationships to incorporate effects of other factors. Hence, the end result becomes that methylmercury in biota is related linearly to mercury in surficial sediment.

Although this simplified linkage assumes a linear relationship between methylmercury in fish tissue and inorganic mercury in surficial sediment, the relationship may not be 1:1. The linear relationship implies proportionality between mercury in various environmental compartments. For example, the use of BAFs assumes that methylmercury in fish tissue is directly proportional to methylmercury in water. As more information becomes available, staff may present an updated linkage analysis to the Regional Water Board during the periodic review of this Basin Plan Amendment.

Assumptions of a linear relationship between methylmercury concentrations in fish tissue and concentrations of mercury in sediment have been used previously for TMDLs for other waterbodies. This assumption has been made in the mercury TMDL for the Savannah River in Georgia, the draft TMDL for San Francisco Bay, and in preliminary modeling for the Florida Everglades TMDL (Abu-Saba and Tang, 2000, Tetra Tech EMI, 2001). Researchers working in the Experimental Lakes Area in Ontario found that within a given ecological system (such as a lake), the concentration of mercury in the water column was a good predictor of methylmercury levels in fish. The relationship broke down during comparisons across different types of lakes (Kelly et al., 1995; Waldron et al., 2000). Researchers in the Florida Everglades also found that within ecosystem types (such as eutrophic wetland or oligotrophic wetland), significant relationships existed between methylmercury in the water and total mercury in the water or sediment (Stober et al., 2001). Clear Lake is a single, shallow, eutrophic waterbody. With the exception of the area of the Oaks Arm influenced by acid rock drainage from SBMM, conditions for bioavailability are thought to be relatively uniform throughout the lake.

Meeting the recommended water quality objectives would require reduction of existing fish tissue concentrations of mercury by 60%. Using the linear relationship described above, the linkage analysis indicates that overall mercury loads to Clear Lake sediment must be reduced by 60% in order to reduce methylmercury concentrations in fish tissue by the proportional amount. Regional Water Board staff is establishing the assimilative capacity of inorganic mercury in Clear Lake sediments as 70% of existing levels to include a margin of safety of 10% to account for the uncertainties in the linkage analysis.

Mercury is distributed throughout lake sediment, with higher concentrations near the SBNN site. Two models have been developed that describe mercury fate and transport in Clear Lake. One is a model of aquatic fate and transformation of mercury in Clear Lake (Bale, 2000). Application of this model showed that total mercury and methylmercury concentrations in the water could be reasonably modeled as functions of total mercury in surficial sediment. The model was unable to accurately predict concentrations of methylmercury in sediment and water near SBMM, perhaps because of the low acidity and high sulfate conditions resulting from groundwater flow from the mine. The model addressed exchanges of mercury between the atmosphere, water, active sediment layer and burial in deep sediments, but did not address inputs of mercury from SBMM or the watershed.

A second model has been developed of particle transport in Clear Lake. Movements of currents and particles were modeled by Rueda and colleagues at the Department of Environmental Engineering at UC

Davis (Rueda, 2001a; Rueda, 2001b). Rueda's 3-dimensional, hydrodynamic model addressed water flow and particle transport within and out of Oaks Arm. The hydrodynamic model is relevant to mercury transport because much of the mercury in the lake is sorbed to particles. Results showed that particles formed near the mine site can be relatively rapidly carried into other arms.

### *5.3.1 Effectiveness of Mercury Removal at Other Sites*

Remediation of mercury-contaminated sites in the eastern United States began in the early 1970s, primarily at sites contaminated due to chloralkali plants or other industrial operations. Authors of a review of this data concluded that mercury concentrations in biota typically decreased following reductions in loading from contaminated terrestrial sites or point sources (Turner and Southworth, 1999). In a number of cases, declines in fish tissue levels were significant soon after remediation, but slowed with time. In the 35 years or less since remediations were undertaken, in only a few waterbodies have fish tissue concentrations declined sufficiently for consumption advisories to be removed. Remediation efforts were also less effective at lowering fish tissue concentrations as distance from the mercury source was increased. Mercury residing in sediments or low-level, ongoing releases was thought to be the main cause of slow recoveries. These authors also concluded that relationships between inorganic mercury and bioaccumulation appear to be highly site-specific in nature. The following text provides several examples of projects that resulted in decreased biota mercury concentrations (Southworth et al., 2000; Turner and Southworth, 1999).

- Aggressive treatment of discharges from two chlor-alkali plants on the St. Clair River (a portion of the waterway between Lake Huron and Lake Erie) resulted in a decline of mercury concentrations in walleye of Lake St. Clair from 2.3 mg/kg in 1970 to around 0.5 mg/kg in 1995. Although fish concentrations declined considerably, a fish consumption advisory remains in effect for large fish.
- At the Department of Defense compound at Oak Ridge, Tennessee, extensive remediations for mercury loads started in 1983 included filling and capping of an onsite pond and ground and surface water treatment. When monitored in 1996, mercury concentrations in redbreast sunfish near the plant had declined from 1.5 to about 0.5 mg/kg, but concentrations in fish downstream either remained constant or increased slightly. Investigators hypothesize that as new inputs decreased, the relative importance of instream reservoirs of mercury to bioaccumulation increased.
- Following the 1972 closure of a chloralkali plant on the North Fork of the Holston River near Saltville, Virginia, the facility site was capped, seepage from wastewater ponds was treated, and sediments along a 600 m stretch of the river were dredged. Mercury concentrations in rockbass and hogsuckers initially increased, then dropped at a rate of about 6.5% per year from 2.5 mg/kg to 0.9 mg/kg between 1975 and 1995. The initial increase is likely due to simultaneous improvements in other water quality parameters, which initially increased availability of mercury for methylation.
- Following closure of a chlor-alkali plant on the Wabigoon River, Ontario, in 1969, concentrations of mercury in sediment from Clay Lake have generally decreased. Higher sediment concentrations were buried under naturally deposited, less contaminated clay sediment (decline from peak of 70 mg/kg, to approximately 35 mg/kg in the period of 1970 to 1984). Mercury levels in crayfish and fish from the lake have decreased also (Parks and

Hamilton, 1987; Rudd et al., 1983). From 1970 to 1983, concentrations of mercury in crayfish dropped from 10 mg/kg to 1 mg/kg. Over the same period, levels in walleye declined from above 12 mg/kg to 4 mg/kg (concentrations of mercury in age-matched walleye from nearby lakes unaffected by the chlor-alkali plant were around 0.6 mg/kg, due to natural background and atmospheric deposition of mercury). Fish tissue concentrations in lakes further downstream of the source declined as well, but to a lesser degree than in Clay Lake.

The authors concluded that remediation measures are effective if carried out near to the fish population of concern (Parks and Hamilton, 1987).

### 5.4 Reductions in Mercury Loads Needed to Attain Water Quality Objectives

The linkage analysis showed that concentrations of mercury in surficial sediment must be reduced by 70%. Reducing concentrations of mercury in sediment by 70% is an overall goal for the entire lake. This load reduction should not be applied evenly across the lake, however. At the eastern end of Oaks Arm 0.3 miles from SBMM, sediment concentrations of mercury reach 200 mg/kg or more (Suchanek et al., 1997). If mercury levels were reduced to 100 mg/kg, concentrations in these sediments would still be far higher than mercury concentrations in other arms needed to meet the water quality targets and higher than present-day concentrations in other arms.

Instead of a single mercury concentration to be achieved in all arms of the lake, Regional Water Board staff recommends reducing mercury concentrations in surficial sediment in Clear Lake to a pattern similar to pre-mining levels. Deep sediment cores show that pre-mining concentrations of mercury were lowest in Upper Arm (0.1-0.4 mg/kg; average 0.2 mg/kg), followed by Lower Arm (0.4-2.0mg/kg; average 1.0 mg/kg) and Oaks Arm (range 3.8-36 mg/kg; average 11 mg/kg; see plots of deep cores in Appendices B and D). Target concentrations in sediment are higher than pre-mining levels, but are developed with the pre-mining pattern in mind. Needed reductions in sediment concentrations are shown in Table 4. Mercury concentrations will vary within each arm, even after the reductions in sediment loads are achieved. To evaluate progress in achieving targets, therefore, sediment concentrations should be examined at sites that have been sampled previously.

The acceptable sediment levels shall be met by the following reductions in existing loads:

- **Atmospheric Deposition.** The allocation for atmospheric deposition is capped at the maximum load estimated to accumulate on the lake surface from the global atmospheric pool, 2 kg/year (Mercury from the global pool that deposits terrestrially and enters the lake in runoff is included in the estimate of tributary loads). This annual load is minimal, relative to loads from the tributaries and SBMM. Control of atmospheric mercury originating outside of the Clear Lake watershed is beyond the jurisdiction of the Basin Plan. Reducing mercury in air is a long-term goal being addressed nationwide through USEPA's strategy to control utility emissions and other state, national or multi-national efforts. The loads from SBMM transported to Clear Lake through the atmosphere are included below in the load allocation for SBMM. Mercury from SBMM that fluxes into the air and deposits locally is expected to be controlled by ongoing USEPA Superfund remediation activities.

- **Tributaries and Surface Water Runoff.** Mercury inputs from tributaries and direct surface water runoff should be reduced to 80% of existing inputs (load allocation is 80%). The inputs from tributaries and surface runoff vary with precipitation and water flow and are estimated to range from 1 to 60 kg/year, depending on type of water year. For an average water year, the estimated load and load allocation are 18 kg/year and 14.4 kg/year, respectively. The load allocation is to be applied to tributary loads as a whole, rather than to each tributary individually. Reductions in mercury loading to meet the load allocation should be focused on controlling mercury from hot spots. Hot spots may include soils particularly enriched in mercury, geothermal springs and small mercury mine sites in the watershed. Production of methylmercury tends to be higher in wetlands than in open water. The plans for any proposed wetland, floodplain or similar restoration projects should assess the potential for the project to contribute methylmercury to Clear Lake.
- **Sulphur Bank Mercury Mine.** The remainder of load reductions will come from reducing inputs to surficial lakebed sediments from existing discharges and historical deposits from SBMM. The load allocation is assigned to the current and future owners of SBMM. Ongoing inputs from the terrestrial mine site must be reduced by 95% to ensure that surficial sediment concentrations will decline sufficiently to meet the water quality objectives for the lake (the load allocation is 5% of ongoing loads). Ongoing inputs include local deposition of mercury fluxed into the air and mercury in groundwater and surface water discharges. Because mercury in groundwater from the mine site is preferentially methylated, the load from SBMM groundwater is limited to 0.5 kg/year. Active mining operations, erosion and other mercury transport processes at SBMM have contaminated sediment in Oaks Arm. Load reductions from SBMM include reducing surficial sediment concentrations in Oaks Arm by 70% (more at sites nearest the mine site) to meet the sediment compliance goals in Table 4. The load allocation to the active sediment layer is expressed as reducing the concentration of total mercury in the active sediment layer to 30% of current concentrations.

Table 4. Sediment Compliance Points Corresponding to Numeric Targets in Clear Lake

| | | **Average Concentration in Surficial Sediment** (mg/kg dry weight) | |
|---|---|---|---|
| **Location** (a) | **Description** | Existing (b) | Sediment Goal to meet water quality targets (50% of existing concentration) |
| Upper Arm: UA-03 | Center of Upper Arm on transect from Lakeport to Lucerne | 2.8 | 0.8 |
| Lower Arm: LA-03 | Center of Lower Arm, northeast of Konocti Bay | 3.6 | 1 |
| *Oaks Arm:* | | | |
| OA-01 | 0.3 km from SBMM | 209 | 16 ( c) |
| OA-02 | 0.8 km from SBMM | 92 | 16 ( c) |
| OA-03 | 1.8 km from SBMM | 53 | 16 |
| OA-04 | 3 km from SBMM | 34 | 10 |
| Narrows 01 | 7.7 km from SBMM | 10 | 3 |

(a) Sampling sites are shown on Figure 1.
(b) Upper Arm and Lower Arm concentrations are averages of surficial sediment levels in 1996 and 2000 sediment core samples. Oaks Arm concentrations are averages of surficial sediment samples collected in 1996-1998. See Appendix B
(c) Due to the exceptionally high concentrations existing at the eastern end of Oaks Arm, sediment goals at OA-01 and OA-02 are not 50% of existing concentrations. These goals are equal to the sediment goal established for OA-03.

## 5.5 Concentrations of Mercury in Sediments from Tributaries Contributing to Burial of Mercury in the Lakebed

Lakebed sediments in Clear Lake are continually being buried beneath more recently deposited sediments. This sediment burial is a natural, ongoing process in Clear Lake. Deep sediment cores from Clear Lake provide a continuous record of sediment deposition, dated from 5000 years ago or more to the present (Sims et al., 1981; Suchanek et al., 1997). In the central parts of each arm where core samples have been collected, sedimentation rates are estimated to be 0.6 – 1.3 cm/year (Suchanek et al., 1997). Lakebed sediment originates from tributary stream and direct surface water runoff into the lake (Richerson et al., 1994).

Deep sediment cores collected in 1996 (Suchanek et al., 1997) and 2000 (unpublished data collected by UC Davis Clear Lake Environmental Research Center for the Regional Water Board, see Appendices B and D) generally show that sediment concentrations of mercury have declined from peak concentrations reached during open pit operations. Lakebed sediment concentrations have declined primarily because sediment from tributaries contains less mercury per unit sediment than lakebed sediment (Table 5).

Levels of mercury in incoming sediment can be estimated by examining the mercury concentrations in fine-grained sediment in depositional zones at the mouths of tributaries. Mercury on suspended and fine, deposited sediments can be compared with levels of mercury in lake surficial sediments. In April 2001, Regional Water Board staff collected fine-grained sediments from depositional zones at the mouths of three tributaries to the Upper Arm. Mercury concentrations in deposited sediment from the tributaries are shown in Table 5. The streambed sediment concentrations from 2000 are similar to previously published values (Varekamp and Waibel, 1987). For comparison, sediments in Upper Arm were 0.1-0.3 mg/kg in the pre-mining period and are 2-4 mg/kg at present (Table 3). The effectiveness of incoming sediment from a particular tributary to dilute or bury lakebed sediment depends upon the mercury concentration and volume of incoming sediment. The concentrations of mercury in Shindler Creek sediment are higher than in other tributaries, but the estimated mercury load from Shindler Creek is low because its flows are relatively minor.

Because concentrations of mercury in tributary sediments reaching the lake are lower than existing lakebed concentrations, reducing mercury loads from the tributaries should be focused on decreasing loading from sites that are enriched in mercury, relative to the rest of the watershed. All of the implementation alternatives described below depend, to some degree, on burial of contaminated sediments under cleaner sediment (passive sedimentation).

Table 5 Mercury Concentrations in Sediment Samples from the Mouths of Clear Lake Tributaries Compared with Lake Sediment Concentrations

| Location | Total Mercury Concentration (mg/kg dry weight) | |
|---|---|---|
| | 2001 (a) | 1987 (b) |
| Upper Arm Tributaries: | | |
| Cole Creek | 0.141 | na |
| Kelsey Creek | 0.058 | 0.046 |
| Rodman Slough @ Nice-Lucerne Cutoff | 0.072 | 0.044 - 0.184 |
| Morrison Creek | na | 0.119 |
| Unnamed tributary to north side of Narrows | na | 0.283 |
| Shindler Creek (tributary to Oaks Arm) | na | 0.73 |

(a) Regional Water Board staff focused on tributaries with sufficient fine-grained sediment for sampling. Tributary samples were collected in April 2001.
(b) Source: Varekamp and Waibel, 1987.

## 5.6 Implementation Alternatives Considered

Five alternatives were considered for Regional Water Board's implementation plan for achieving the sediment compliance goals and mercury water quality objectives. The first is the "No Action" alternative, under which no active remediation would be required. The other four alternatives require some level of active remediation. Under Alternatives 2 through 5, the load reduction from the tributaries is the same and the contribution from the atmospheric mercury pool is assumed to be constant. The main differences in Alternatives 2-5 are the levels of abatement that are required for past and present discharges from the SBMM site and how long it will take for improvements to occur.

All of the implementation alternatives will require outreach to educate the public regarding the levels of fish consumption that may cause adverse health effects. Regular reporting to the Regional Water Board regarding progress toward meeting objectives is proposed for all alternatives.

The alternatives are compared on the basis of length of time to reach the necessary reduction of 70% in surficial sediment concentrations. Allowing for turnover in the fish population, staff estimates that fish tissue objectives would be achieved within ten years after surficial sediment concentrations of mercury have stabilized at the desired levels.

### *5.6.1 Alternative 1. No Action - Passive Burial of Sediments Contaminated with Mercury*

The no-action alternative relies completely on passive burial of contaminated sediments under cleaner, incoming sediment to decrease concentrations of mercury in surficial sediment. Regional Water Board staff estimates that sediment goals will be reached in Upper and Lower Arms by passive sedimentation within 85 years. Sediment goals for the west end of Oaks Arm and the Narrows are estimated to be reached in approximately 105 years. If the highly-contaminated sediment at the eastern end of Oaks Arm does become covered with cleaner sediment, it is estimated that sediment concentration goals for Oaks Arm would be reached in 285 to over 1200 years, depending upon the rate of sedimentation in this area (Table 6). These estimates assume that: 1) mercury concentrations continue to decline as in the past and

2) declines in mercury concentrations observed at sediment sampling sites are representative of declines across the lakebed.

It is highly unlikely that the sediment goals and fish tissue objectives would be reached through passive sedimentation alone. Table 6 provides a probable best-case scenario, based on declines in mercury levels at selected sites in the lake. More sediment cores need to be examined to verify that sediment is being buried across the lakebed. There are two other major uncertainties that should be resolved before relying on estimates in Table 6. First, mercury concentrations in surface sediments collected in 1996 and 2000 from various parts of the lake were virtually unchanged. This lack of difference between surficial sediment collected in different years could be due to inherent variation within a downward trend, or may indicate an equilibrium in mercury concentrations has been reached between the ongoing inputs to surficial sediment and sediment burial. If an equilibrium has been reached, additional declines in surficial sediment concentrations of mercury will not occur without a reduction in ongoing inputs. Second, sediment may not be accumulating over the highly-contaminated material near the shore of SBMM. Under the prevailing northwest-to-southeast wind conditions typical for Clear Lake, this end of Oaks Arm is subject to wave scour. Wave action may prevent fine sediments from depositing permanently over materials that came from SBMM during active operations and erosion. Researchers from Humboldt State University were unable to collect cores from the lakebed close to the mine site due to the presence of cobbles (Chamberlin et al., 1990). Even assuming that surface concentrations of mercury are declining slowly, sediment goals at the east end of Oaks Arm would not be reached until approximately the year 3280. Because fine particles are known to move from the east end of Oaks Arm to other parts of the lake, it could take until this time to achieve the fish tissue objectives in Clear Lake. Under Alternative 1, it is probable that fish tissue concentrations would never approach natural background levels because there would be an ongoing discharge from the mine site.

*Rates of Decline in Sediment Mercury Concentrations*

The numbers of years to reach the sediment compliance goals were estimated by examining deep core samples that showed a consistent decline in mercury concentrations over a depth of 20-30 cm and determining the rate of decline observed between the past, peak levels and the present concentration at the core surface. The rate of decline in mercury concentrations (expressed as a percent decline observed per year) was then applied to existing surficial sediment concentration to determine the estimated length of time to reach the desired sediment concentrations. For sites nearest to SBMM (e.g., OA-01, at which deep sediment cores have not been collected), a range of percent declines was applied to the existing surficial sediment concentration to estimate years to the sediment goal.

Table 6. Years to Reach Sediment Compliance Goals with Passive Sedimentation

| **Location** | **Decline in Sediment Mercury Concentrations** (percent decline per year) (a) | **Estimated Number of Years to Reach 70% Decrease in Surficial Sediment Concentrations** (b) |
|---|---|---|
| *Upper Arm* | | |
| Core at UA-02 | 1.9% | 73 |
| Core at UA-03 | 1.3% | 84 |
| *Lower Arm* | | |
| Core at LA-03 | 1.8% | 70 |
| *Oaks Arm* | | |
| Oaks Arm center (site OA-03) | 1.3% | 104 |
| Oaks Arm - site 0.3 km offshore of SBMM (c) | 1.3% | 197 |
| Oaks Arm - site 0.3 km offshore of SBMM (c) | 0.2% | 1280 |

(a) Rates of decline were obtained from deep sediment cores collected in 1996 and 2000. See Clear Lake TMDL Report for core data. The rates were obtained from cores that that exhibited a decrease in mercury concentrations from the most recent peak (~1960s) over a depth of at least 20 cm. The percent decline reported is the average rate of decline between concentration data points in this core segment. Segments of sediment cores were dated using the concentrations of lead-210, which allowed conversion from depth of the core segment to year (Suchanek et al., 1997; Suchanek et al., 2001 in the Clear Lake TMDL Report).

(b) Estimation of the years to reach the sediment goals assumes that the sediment concentrations of mercury continue to decline as shown in column 2. It is uncertain whether these rates of decline are continuing.

(c) Changes in sediment concentrations of mercury have not been measured near the shore of SBMM. Two rates of decline were compared: the same as that measured at site OA -03, and a lesser rate to take into account less sediment deposition near shore.

Applying the estimated years in Table 6 to reach sediment goals to the broader goal of reducing mercury concentrations in sediment across the lake by 70% requires the assumption that the rates of mercury decline observed at these deep core sites occurs across the lake. Deep sediment cores collected at various sites in the lake generally exhibit a decline in mercury concentrations from the most recent peak, which typically occurs in the 1960s, several years after the cessation of mine operations (Suchanek et al., 1997; Clear Lake TMDL Report). Sedimentation rates and rates of decline in mercury concentrations likely vary across the lake, however. In shallow waters, in particular, cores have not been collected to determine sedimentation rates. The estimated times (listed in Table 6) to reach sediment goals are useful for estimating the time to attain the water quality objectives and for making relative comparisons between implementation alternatives. As proposed in the amendment to the Surveillance and Monitoring Chapter, regular monitoring of sediment and fish tissue concentrations throughout the lake will allow Regional Water Board staff to track progress in meeting the Basin Plan goals and objectives.

### *5.6.2 Alternative 2. 70% Reduction of Past and Present Mercury Inputs from SBMM Combined with Natural Sedimentation*

This alternative is the plan that was proposed in the Clear Lake TMDL Report distributed for comment in November 2001. Under this alternative, significant reductions in the current discharge from the mine would be required and significant work would be required to address the most contaminated part of the lake sediment near SBMM (a total load reduction of 70%). These abatement activities would be implemented over the next 10-15 years. Actual methods of achieving the 70% load reduction would be determined by responsible parties of the mine site or entities conducting remediation (the USEPA Superfund Program is requested to continue work at the site). Forseeable methods of compliance with this alternative include surface and groundwater controls and capping of waste piles on the mine site and dredging or capping of highly contaminated lakebed sediment. Natural sedimentation would allow the remaining contaminated sediment in Oaks Arm and the rest of the lake to become buried.

As a result of the active remediation efforts, sediment concentrations in Oaks Arm would be expected to improve more rapidly than under Alternative 1. For example, if sediments at site OA-03, 1.8 km from the mine site, were dredged to remove sediments with concentrations greater than 25 mg/kg (a depth of 60 cm or 24 inches) and natural sedimentation allowed to follow, the sediment goal for this site would be reached in about 50 years. Sediment goals for Lower and Upper Arms would presumably be reached in less than the time estimated for natural sedimentation alone. Because the Table 6 time estimates likely represent a best-case scenario for natural sedimentation and because most of this alternative's active remediation would be conducted in Oaks Arm, 80 years is still a reasonable estimate of time to reach the desired sediment concentrations in Upper and Lower Arms. Fish tissue objectives would be expected to be attained within 10 years after sediment goals are reached. Under this alternative, it is probable that fish tissue concentrations would never approach natural background levels because there would be a continuing discharge from the mine site.

This alternative would require that the USEPA Superfund Program submit a remediation plan for reducing mercury from SBMM. The remediation plan for SBMM should address inputs of mercury that are ongoing, including transport through surface water, groundwater and air. The plan should also address effects of and any necessary remediation of ongoing contributions to surficial sediment from mercury previously deposited in the lake as a result of through mine operations, erosion and other processes at the mine site.

Implementation of a 20% decrease in mercury loads from the tributaries may be developed using a phased approach. First, monitoring plans for identifying mercury hot spots within the tributary watersheds should be submitted to the Regional Water Board by federal landowning agencies (U.S. Bureau of Land Management and U.S. Forest Service), other landowning agencies, and the Lake County. Second, the above-named groups should develop implementation plans to reduce mercury loading from the hot spots. Regional Water Board staff will coordinate with the above named agencies and other interested parties, including Native American Tribes, to develop the monitoring and implementation plans. The named agencies may coordinate to develop one monitoring and remediation plan or may submit separate plans.

The Regional Water Board will review the progress toward meeting the water quality objectives for Clear Lake every five years. The review should be timed to coincide with the USEPA's five-year review of the Record of Decisions for the Sulphur Bank Mercury Mine Superfund Site.

This alternative would be moderately expensive. The USEPA is developing estimates for SBMM site abatement activities. Abatement options for the contaminated lakebed sediment have not been evaluated. This implementation plan would require the necessary evaluations for environmental impact and feasibility. Staff estimates, based on cleanup efforts elsewhere, that total costs could range between $52 and $285 million dollars, including costs for mine site, contaminated sediment and tributary cleanups, monitoring and public outreach. Narrowing this broad range mainly depends upon the costs of remediating and/or ensuring burial of the highly contaminated sediment near the mine site. Of these estimates, the terrestrial mine site cleanup could cost $31-45 million dollars for surface and groundwater treatments and capping of waste rock.

### 5.6.3 Alternative 3. Near-Zero Discharge from SBMM and Removal of all Contaminated Sediment from the Lake

Under this alternative, the current discharge from the terrestrial mine site would be reduced by 95% (allowable input of 5% of existing inputs). Ongoing contributions of mercury from the contaminated sediment across the entire lakebed would also be reduced by 95% by removing the contaminated sediment or implementing some other abatement option (burial for example). These abatement actions would be required to be implemented over the next 10-15 years. Reducing existing sediment mercury concentrations across the entire lake by 95% would essentially return the sediment concentrations to natural background. Assuming a lag period of about 10 years between reaching sediment goals and observing the effect in fish tissue, this alternative would be expected to result in achievement of the fish tissue objectives within 25 years of the start of implementation. Identification and remediation of hot spots in tributaries to reduce tributary loads by 20% would be required as discussed in Alternative 2.

This alternative would be tremendously expensive. Dredging sediment containing higher-than-background concentrations could cost several trillion dollars. Additional costs would be associated with disposal of contaminated sediment. In-place containment of contaminated sediments, by a method such as capping, may be feasible but has not been evaluated. There would be potentially significant environmental impacts of removing large quantities of contaminated sediment from the lake and disposing of it elsewhere.

### 5.6.4 Alternative 4. Near-Zero Discharge from the SBMM, Removal of Some of the Highly Contaminated Sediment from Lake and Natural Sedimentation

This option is similar to Alternative 2, except that the ongoing discharge from the terrestrial SBMM site would be reduced by 95%. Abatement actions would be required to address the most contaminated lakebed sediment with the goal of achieving a relatively short term (10-15 years) 70% reduction in contributions of mercury from sediment in the east end of Oaks Arm. Natural sedimentation would be allowed to cover the contaminated sediment in the remainder of the lake. Staff estimates that natural sedimentation rates would take about 80 years for mercury concentrations in lakebed sediments to reach a new equilibrium. Fish tissue concentrations would be expected to meet the fish tissue objectives within 10 years thereafter. Under this alternative, staff would expect significant improvements in fish tissue concentrations over the next 25 years and a slower rate of improvement for the remaining 55 years.

This alternative would be only slightly more expensive than Alternative 2. Costs of abatement at the terrestrial mine site could be $40-55 million dollars, for remedies such as covering waste rock with a liner and soil cap, surface water controls and/or treatment and groundwater controls. Remediation of highly contaminated sediment in the east end of Oaks Arm to ensure a 70% reduction in mercury contributions from this area could cost $20-230 million dollars, depending upon whether sediment is dredged or capped, the type of dredging, and disposal costs. The USEPA has estimated that mercury loads carried in groundwater from Herman Impoundment could be essentially eliminated after remediation. The feasibility of achieving near-zero discharges from other routes of mercury transport from the mine site (groundwater infiltration through the waste rock dam, surface and other groundwater transport and flux to the atmosphere) will be determined as part of USEPA's remedial investigation and feasibility analysis for the mine site.

### 5.6.5 *Alternative 5. Near-zero Discharge from the SBMM, Removal of Most of the Highly Contaminated Sediment from Lake and Natural Sedimentation*

This alternative is similar to Alternative 4. The only difference is that it requires a 95% reduction in contributions of mercury from the highly contaminated sediment nearest to the mine site. Ongoing inputs from the terrestrial mine site must be decreased by 95%. Mercury concentrations in surficial sediments in the rest of the lakebed would be buried by natural sedimentation. Under this alternative, it would still take approximately 80 years for the lake to reach a new equilibrium and approximately 10 years thereafter for fish tissue concentrations to meet the fish tissue objectives. However, under this alternative staff would expect more dramatic decreases to occur within the first 25 years because of additional remediation actions in the sediment offshore of the mine site. It is very difficult to predict exactly how much of a short term difference could be expected by requiring a 95% reduction.

This alternative would be more expensive than Alternative 4 because more extensive remediation would be expected in the highly contaminated sediments. Staff estimates that going from a 70% reduction to a 95% reduction could cost an additional $10 to $80 million, depending upon the type of sediment containment or dredging and disposal used. As has been previously pointed out, it is very difficult to predict how much of a short term difference this additional expense would make in fish tissue concentration.

Table 7 provides a comparison of the implementation alternatives. It is anticipated that the USEPA Superfund Program would implement remediation activities at the mine site and the lakebed sediment to achieve the water quality objectives for the majority of load reductions needed. However, under the time schedule for this alternative, meeting sediment goals in Lower and Upper Arms would presumably not require dredging or other method of active remediation. Sediment goals in Lower and Upper Arms would be met primarily by passive sedimentation. The cost estimates for this alternative reflect this assumption.

Table 7. Comparison of Implementation Alternatives

| | **Remediation Goals** | | | |
|---|---|---|---|---|
| **Alternative** | Ongoing Inputs from Terrestrial Portion of Sulphur Bank Mine Site | Contributions from Mine-related, Highly Contaminated Sediments in East End of Oaks Arm | Surficial Sediment in Upper Arm, Lower Arm, and west end of Oaks Arm | Tributary Loads |
| 1 | Natural sedimentation | Natural sedimentation | Natural sedimentation | No action |
| 2 | 70% reduction | 70% reduction | Natural sedimentation | 20% reduction |
| 3 | 95% reduction | 95% reduction | 95% reduction within 15 years | 20% reduction |
| 4 | 95% reduction | 70% reduction | Natural sedimentation | 20% reduction |
| 5 | 95% reduction | 95% reduction | Natural sedimentation | 20% reduction |

## 5.7 Evaluation of Alternatives

### *5.7.1 Attainment of Water Quality Objectives*

It is unlikely that water quality objectives would be attained under Alternative 1. Mercury entering Clear Lake through groundwater from SBMM is thought to be methylated more readily than mercury in the sediment (Suchanek et al., 2001, Appendix E). Mercury levels in fish tissue may not decline sufficiently without control of this source. Additionally, it is not known whether rates of decline in sediment mercury concentrations observed in deep sediment cores are continuing in the present.

Water quality objectives and sediment compliance goals are expected to be achieved under Alternatives 2-5. Assuming that the mercury levels in the food web respond proportionally to changes in sediment mercury concentrations, it is estimated that fish tissue objectives will be achieved approximately ten years after the sediment goals are met.

Under Alternative 2, if sediment concentrations continue to decline uniformly across Upper and Lower Arms as has been noted at some sediment core sites, the fish tissue objectives could be achieved within 90 years. Alternative 3 requires that sediment goals be met by active remediation within 15 years, such that water quality objectives would be met within 25 years after the Basin Plan amendment is enacted. Alternatives 4 and 5 require more extensive remediation activities at the terrestrial SBMM site and in highly contaminated sediment than Alternative 2. Therefore, under Alternatives 4 and 5, water quality objectives would likely be attained between 25 and 90 years. How quickly sediment and fish tissue concentrations will improve with additional remediation activities is difficult to predict. Under any of the Alternatives 2-5, more rapid improvements in fish tissue concentrations are expected to occur soon after remediation activities are completed, with more gradual declines in fish tissue concentrations occurring as sediment concentrations continue to decline through natural sedimentation.

### *5.7.2 Cost*

Estimated costs for mercury control and other activities that might occur under the proposed implementation plan are shown in Table 8 at the end of this section. These are rough estimates designed to facilitate comparisons between the implementation alternatives. These estimates may be refined through the USEPA's feasibility analyses for SBMM and any identified hot spots within tributary watersheds.

No construction or maintenance costs are projected for Alternative 1 (No Action – Natural Recovery of Sediments). Implementation of Alternative 1 would still have monitoring and public outreach costs associated with it.

Alternative 3, involving rapid remediation of sediments over the entire lakebed, has the greatest projected costs associated with it. Alternative 3 costs are possibly in the trillions of dollars, if dredging were to be performed.

Alternatives 2, 4 and 5 differ in the required reductions in inputs from the terrestrial SBMM site and ongoing contributions from the highly contaminated sediments in the east end of Oaks Arm. Presuming that remediation costs are directly proportional to mercury load reduction goals, costs would increase in order from Alternative 2, followed by 4 and 5. Alternative 4 costs of abatement at the terrestrial mine site could be $40-55 million dollars, for remedies such as covering waste rock with a liner and soil cap, surface water controls and/or treatment and groundwater controls. Additional remediation of the east end Oaks Arm sediments under Alternative 5 could add $10-80 million dollars to the costs of Alternative 4.

### *5.7.3 Feasibility*

The implementation alternatives were evaluated regarding likelihood of completion of the implementation plans and feasibility of remediation activities. Alternative 1 is feasible because no implementation plans or remediation activities are proposed.

Achieving the sediment compliance goal of 26 mg/kg within 15 years under Alternative 3 would likely require dredging, capping with clean sediment or other remediation method for most of the lakebed. Given the large size of Clear Lake (43,000 acres) it is unlikely that remediation of this area is technically feasible. Dredging or capping sediment would likely cause significant disruption or impairment of the Clear Lake ecosystem. Sediment-dwelling insect larvae (chironomids) are very important prey items for juvenile and trophic level 3 fish in Clear Lake. Extensive sediment disturbances could significantly suppress this key component of the food web.

Alternatives 2 4 and 5 are assumed by Regional Water Board staff to be technically feasible, based upon general knowledge of mercury transport from SBMM and within the lake and effectiveness of remediations conducted elsewhere. However, actual feasibilities and costs of remediation activities at SBMM have not been determined. USEPA anticipates releasing a Remedial Investigation/Feasibility Study for the terrestrial mine site by December 2002, with selection of a remedy to follow. Investigations of mercury in the lakebed are ongoing by USEPA. Regional Water Board staff recommends that USEPA complete its investigations of mercury in the lake before an implementation plan is prepared. Development and review of remediation options for the wetlands near the mine site, lakebed and any other compartments impacted by mercury from SBMM will take some time after the investigations have been completed. Regional Water Board staff will continue to work with USEPA to verify that the load allocations of the recommended alternative can be met.

If additional information reveals that reaching 95% reduction in mercury loads from the terrestrial mine site is technically infeasible or cost prohibitive, the Regional Water Board will consider alternative proposals from the USEPA Superfund Program to slightly adjust the load allocations. Adjusted load allocations should achieve the same overall reduction in loads from mine-related sources (terrestrial mine site and ongoing contributions from highly-contaminated sediments), but could be refocused in terms of the reductions from the terrestrial mine site versus highly-contaminated sediments. For any adjustment in load allocations, mercury loads from the terrestrial mine site must be reduced by at least 85% of existing loads.

Alternative 3 is considered feasible in terms of plan development and application. Implementation plans for reducing mercury loads from SBMM are expected to be completed by the eight-year time period proposed in Alternative 3. USEPA's decision-making process for remediation of mine site-related mercury is a multi-step process, which includes remedial investigations, feasibility studies, review, approval of funding, and selection of final remedies. Remedial investigations and feasibility studies for the mine site itself are expected to be completed by late 2002. USEPA is conducting some studies of wetlands near SBMM, but has not started investigations within the lake. The USEPA Superfund Program's studies on the mine site have contributed substantially to the understanding of concentrations, chemistry and transport of mercury on the mine site. Regional Water Board staff recommends that USEPA complete its investigations of mercury in the lake before an implementation plan is prepared. The Regional Water Board staff also anticipates that monitoring and implementation plans for reducing tributary and surface runoff loads can be prepared under the proposed time schedule.

If investigations show that highly-contaminated material in Oaks Arm is not being buried and is contributing mercury to the surficial sediment layer, control mechanisms for these materials would be needed. Sediments possibly in need of remediation are estimated to cover 270 acres in the eastern end Oaks Arm to a depth of 0.3-1.0 meters. For this estimation, sediments possibly needing remediation were defined as sediments with mercury concentrations greater than 50 mg/kg dry weight. Once the most contaminated material is removed and the lakebed recontoured, it is likely that sediment would accumulate over this area. The reduction in sediment concentrations from 50 mg/kg to the sediment compliance goal of 26 mg/kg could then be achieved by passive sedimentation. Depth and surface area estimations were obtained from core samples (Appendix B; Chamberlin et al., 1990; Suchanek et al., 1997).

## 5.8 Recommended Alternative

Regional Water Board staff recommends Alternative 4 as providing the best balance between cost and feasibility. Alternative 4 provides for meeting sediment compliance goals within 80 years. Regional Water Board staff believes this is a reasonable timeframe, given the complexity of mercury cycling in the ecosystem, the presence of mercury pollution throughout the lake, and the length of time that mercury levels in Clear Lake have been increased due to anthropogenic activities.

Alternative 1 is not acceptable because water quality objectives are unlikely to be met under a plan of sedimentation alone. Alternative 3 would be extremely costly to implement and could impair the environment if the majority of the lakebed were remediated. Alternative 2, which requires 70% reductions from the terrestrial mine site and the highly-contaminated sediment, may not result in attainment of water quality objectives because 30% of the inputs from SBMM would still be allowed. Alternative 5 would likely cause unnecessary expense in remediation of nearly all of the highly contaminated Oaks Arm sediments. If a majority (i.e., 70% as in Alternative 4) of the contaminated material is removed or burial is somehow ensured, mercury levels in these areas would likely be reduced further by natural sedimentation at no additional cost.

## 5.9 Public Outreach and Education

A necessary component of the Clear Lake mercury strategy is public education. Public outreach would accompany any of the implementation alternatives discussed above. Until the water quality objectives are attained, the public should continually be informed about safe fish consumption levels. The existing fish consumption advisory for Clear Lake is included in every copy of the California Department of Fish and Game's fishing regulations. This effort may be insufficient, however, to inform consumers of the risks of mercury in locally-caught fish. Sensitive groups of consumers, such as pregnant women and children, may not catch fish themselves and are less likely to receive the advisory information.

To augment existing efforts to publicize the fish consumption advisory, the proposed Basin Plan amendment requires additional outreach and education in the Clear Lake area. Education should be directed toward portions of the population that may be particularly at risk, such as pregnant women and children and those with high consumption rates. The proposed Basin Plan amendment names the Lake County Public Health Department as the lead agency for education and outreach. The Regional Water Board and the California Department of Health Services will coordinate with Lake County to provide these services. Education efforts may include recommendations to eat smaller fish and species having lower mercury concentrations. Educational messages should also include the levels of fish consumption, activities in the lake, and routes of exposure that do not result in mercury toxicity.

Table 8. Estimated Costs of Potential Remediation Activities to Reduce Mercury in Clear Lake

| Remediation Activity | Description of Activity | Unit | Estimated Cost (a) |
|---|---|---|---|
| No action. | Some of the contaminated sediment is expected to be buried passively under cleaner sediment entering Clear Lake and tributaries and direct surface water runoff. | | $ 0 for mercury control activities (public outreach and monitoring expenses would still occur; see below) |
| **Mine site**<br>Manage waste rock piles and Herman Impoundment to control transport of mercury through surface water, groundwater and air into Clear Lake. Eliminate risk to persons walking or residing on site. | Waste rock controls (options range from: covering all or part of waste rock with clean soil with or without liner - $19-27 million; to removing waste rock to Class 1 landfill constructed on-site and revegetating – estimated $63 million). | 2 million cubic yards of waste rock, ore and tailings.<br>123 acres of waste piles and disturbed rock. | $19-63 million |
| | Control surface water and runoff (options range from surface water diversion system to capture and containment of surface water) | 50 million gallons/yr | $180,000 – $3.5 million |
| | Control groundwater | 130 million gallons/yr | $22-30 million |
| | Total Mine Site Remediation | | $41.2 – 69.5 million |
| **Lakebed Sediment**<br>Dredge hot spots in eastern end of Oaks Arm. | Dredge Hot Spots within the Oaks Arm with [Hg]> 50 ppm. (Costs depend on types of dredging, dewatering and disposal) | 270 acres (estimated)<br>0.93 million cy | $56 – 230 million |
| Dredge portion of Oaks Arm. | Dredge portions of Oaks Arms with [Hg]>25 ppm. (Costs depend on types of dredging, dewatering and disposal) | 780 acres (estimated)<br>3.7 million cy | $140 - 930 million |
| Clean fill over hot spots in Oaks Arm. | Deposit clean fill in Oak Arm where [Hg]>50 ppm (Cost and feasibility depends on whether suitable cap material can be identified that will stay in place on sediment surface.) | 270 Acres (estimated) | $20 million estimated. |
| Reduce sediment transport from Oaks Arm. | Reduce Sediment transport from Oaks Arm by subsurface barriers to reduce wind driven currents where [Hg]>25 ppm | 5,000 Linear foot barrier<br>840 acres | |
| Clear Lake watershed. | Continue to implement best management practices for erosion control; continue enforcement of ordinances that control erosion. | | |
| Clear Lake watershed. | Control grazing, off-road vehicle use and other activities that reduce protective vegetation and result in increased erosion. | | |
| Clear Lake watershed . | Design and construct ecosystem restoration, sediment control or mercury hot spot control projects. (Cost estimate is for the Middle Creek Ecosystem Restoration Project, which would satisfy mercury load reduction requirements for the tributaries. Other projects would have variable costs.) | | $40 million |
| Public outreach and education. | | | |
| Monitoring to assess progress toward water quality objectives. | Monitoring of sediment, water and small fish every five years. Every tenth year, add monitoring of large or sport fish. (These figures do not include additional monitoring to assess effectiveness of load reductions at the mine site and in the lake sediment, which should be conducted as part of the remediation. ) | | $35-50,000 every 5 years; additional $40,000 every tenth year. |

(a) Sources: CVRWQCB remediation project at Penn Mine; guidance documents for development of Regional Toxic Hot Spot Cleanup Plans (SWRCB, 1998); reconnaissance report and updates provided by the U.S. Army Corps of Engineers on the Middle Creek Ecosystem Restoration Project; and cost estimates for erosion control best management practices and ordinances provided by Lake County.

# 6 MONITORING

Chapter 5 of the Basin Plan describes the methods and programs that the Regional Water Board uses to acquire water quality information. Acquisition of data is a basic need of a water quality control program and is required by the Clean Water Act and the Porter-Cologne Water Quality Control Act.

A monitoring plan is also an essential element of the Clear Lake mercury reduction strategy. The goal of monitoring is to measure whether mercury loads have been reduced and to track progress in achieving the water quality objectives. Monitoring at Clear Lake will include fish tissue, water and sediment sampling in Clear Lake. The Regional Water Board will coordinate preparation of detailed monitoring plans and obtaining resources to conduct monitoring of sediment, water and fish to assess progress. Proposed modifications to Chapter 5 that provide guidance for monitoring of mercury in Clear Lake are presented in Section 2 of this report.

For all data collection efforts described below, some baseline data are available. Before development of detailed monitoring plans, the existing data will be evaluated by a statistician for completeness, understanding variability in the study population, and designing future sample collections. Statistical analysis is required to assess whether mercury load reductions have resulted in decreased fish tissue levels. More years of data are needed if the variability between the averages of fish-tissue mercury levels is high (e.g., 30% versus 15%).

Section 6.2 contains guidance for water monitoring within the tributaries to Clear Lake. Goals of this monitoring are to refine the estimates of mercury loads from the tributaries and locate any relatively significant sources to the tributaries. Under the proposed Basin Plan amendment (Implementation Alternative 3), U.S. Bureau of Land Management, U.S. Forest Service, other landowning agencies in the Clear Lake Basin, and Lake County shall submit plans for monitoring in the tributaries. The Regional Water Board will coordinate with the above named agencies and other interested parties to develop the plans for monitoring and control actions. While it is intended that the same parties coordinate to conduct the monitoring, funds for performing monitoring in the tributaries have not yet been identified.

## 6.1 Clear Lake Monitoring

### *6.1.1 Fish Tissue*

Fish tissue sampling should be conducted on two levels. One effort should focus on juvenile fish that remain in a relatively defined home territory. Juvenile fish are desired because their methylmercury uptake is largely the result of recent exposure. Juvenile fish will more quickly reflect changes in mercury bioavailability than will larger or older fish, which integrate mercury uptake across years and large spatial areas. Young-of-the-year largemouth bass and inland silversides are recommended for this effort. The largest silversides, greater than 65 mm in length, may be older than one year and should not be sampled. Small fish should be sampled every five years, starting in the year after remediation is begun at SBMM. Composite samples containing multiple fish of the same species and same approximate size are acceptable. Some baseline data for these species have been collected by UC Davis CLERC (Suchanek et al., 2000; Suchanek et al., 1997). The baseline data set should be expanded in order to understand species and inter-annual variabilities in mercury concentrations. Additional baseline data on mercury concentrations in small fish should be collected before control measures are implemented in the tributaries or at SBMM.

Because greater than 85% of total mercury in muscle tissue of fish of these sizes is methylmercury, analysis of muscle tissue for total mercury is acceptable for assessing compliance.

Mercury levels should also be measured in fish of the species and sizes frequently consumed by humans and wildlife. Largemouth bass and channel catfish are recommended because they are at the top of the aquatic food web, are regularly consumed and have the most extensive historical data set of mercury concentrations. Hitch should also be sampled, because they are a preferred resource of the local Native Americans. Adults of these trophic level 3 and 4 species can be effectively sampled every 10 years, starting the year after remediation is begun at SBMM. Because adult fish integrate methylmercury levels over a lifetime and changes in total sediment mercury concentrations are not expected to be discernable for more than five years, more frequent sampling of sport fish is not necessary.

The Office of Environmental Health Hazard Assessment will be consulted during planning for fish sampling. In order to modify or remove the fish tissue advisory, the Office of Environmental Health Hazard Assessment may require that mercury levels be evaluated in other species popular for sport or commercial fishing. Additional species for which mercury concentration data may be requested are white catfish, bullhead, crappie, Sacramento blackfish and bluegill.

### *6.1.2 Sediments*

Total mercury sediment concentrations throughout the lake should be evaluated regularly, preferably on the same time schedule as small fish. Levels of total mercury in sediment can be used to indicate whether loads have diminished. Existing sediment data should be evaluated to determine if there is an adequate baseline of information. A profile of sediment concentrations in Oaks Arm with respect to distance from the SBMM site should be obtained for current conditions. The most recent profile of surficial sediment concentrations in Oaks Arm was completed in 1994-96 (Suchanek et al., 1997).

A better understanding is needed of sedimentation patterns, especially in Oaks Arm. Short cores of sediment should be collected in Oaks Arm to determine to what extent the waste rock and tailings pushed into the lake are being eroded or covered with sediment. Sections of the short cores should be analyzed for total mercury and any other components needed to date the sections and determine sedimentation rates. These short cores should be collected before and after any dredging, capping or other remediation activities in the lakebed near SBMM.

### *6.1.3 Water Column*

Water column samples should be collected simultaneously with fish samples and analyzed for mercury. These samples should be collected from sites in each arm of the lake and from deep and surface water levels. Data from water, fish and sediment samples collected throughout the lake will be used to determine the effectiveness of various mercury load reduction activities.

Water samples should also be collected specifically to monitor the effectiveness of reducing the flow of mercury-containing groundwater from the western shoreline of SBMM (the waste rock dam) into Clear Lake. Prior to and yearly for at least five years after groundwater reduction efforts are completed, water collected offshore should be analyzed for total mercury, pH and possibly other components useful for tracking groundwater flow into the lake. Analyses should be collected on samples from the water column and from porewater (water residing between sediment particles). Various sources of porewater, including lake water, acid mine drainage, Herman Impoundment water and hydrothermal fluids from springs on the mine site, have unique "signatures" in their ratios of chemical elements and stable isotopes (Shipp, 2001). Groundwater flow from the mine site has been determined to be entering Clear Lake by subsurface flow through lake sediments (Shipp, 2001). Surveys of shallow water conducted in transects along the length of the mine face have revealed "hotspots" with low pH and very high sulfate concentrations that indicate preferential pathways of acidic groundwater flow into the lake.

## 6.2 Tributary Monitoring

### *6.2.1 Tributary Sediments*

Sediments from the tributaries to Clear Lake should be monitored to determine whether "hot spots" of mercury loading exist within the tributaries. This information would be used to focus erosion control or other clean-up efforts within the tributaries. In order to achieve maximum effectiveness in reducing mercury loads to the lake, efforts should focus on sources of sediment containing mercury levels higher than the average level in tributary sediment.

Sediments within the tributaries should be collected at the mouths of tributaries and storm water inputs to Clear Lake. Sediments should also be collected at multiple intervals upstream within the tributaries. Sampling sites should be located at secondary stream inputs, significant changes in land use patterns, geothermal springs or other features that might influence erosion rates or concentrations of mercury in the soil. To enable comparisons to be made between sites, sediment samples should be sieved in the field and only the fine sediments (silt/clay fraction, suggested filter size 63 micron) analyzed for mercury.

### *6.2.2 Tributary Waters*

Water in the tributaries should be sampled for the purposes of refining estimates of mercury loads from various tributaries and for identifying sites for remediation. Water sampling in major tributaries should include samples collected in high flow events for mercury and total suspended solids.

# 7 ENVIRONMENTAL CHECKLIST AND DISCUSSION

All Basin Plans and plan amendments are subject to the California Environmental Quality Act (CEQA). The Secretary for Resources has certified the State Board's water quality planning process as meeting the requirements of Section 21080.5 of CEQA. The Basin Planning process is determined to be "functionally equivalent to" CEQA's requirement for preparation of an environmental impact report or negative declaration and initial study. State Board regulations titled "Implementation of the Environmental Quality Act of 1970" describe the environmental documents required for planning actions. These documents include a written report (staff report), an initial draft of the amendment, and an Environmental Checklist Form. The documents must include either alternatives to the activity and mitigation measures to reduce any significant or potentially significant effect that the project may have on the environment or a statement that the project would not have a significant impact on the environment. The staff report and Environmental Checklist must be functionally equivalent to the environmental documents required by CEQA.

The attached checklist was prepared in compliance with this requirement and to assist in identifying potential impacts and outlining mitigation measures. Findings of the checklist are discussed in greater detail following the checklist.

**I. Project title:**
Amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins – Clear Lake Mercury Water Quality Management Plan

**II. Lead agency name and address:**
Central Valley Regional Water Quality Control Board
3443 Routier Road, Suite A
Sacramento, CA 95827-3003

**III. Contact persons and phone number:**
Janis B. Cooke, Ph. D, Environmental Scientist
916-255-3372

Patrick Morris, Senior Water Quality Control Engineer
916-255-3121

**IV. Project location:**
Clear Lake, Lake County, California

**V. Project sponsor's name and address**:
Central Valley Regional Water Quality Control Board,
3443 Routier Road, Suite A, Sacramento, CA 95827-3003

**VI. General plan designation**:
Not applicable

**VII. Zoning:**
Not Applicable

**VIII. Description of project:** (Describe the whole action involved, including but not limited to later phases of the project, and any secondary support or off-site features necessary for its implementation. Attach additional sheets if necessary.)

The Central Valley Regional Water Quality Control Board proposes to amend the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins. The purpose of the amendment is to include commercial and sportfishing as a beneficial use, to establish water quality objectives for mercury (by adopting a mercury concentration in fish tissue) and to implement a total maximum daily load water management strategy for mercury in Clear Lake. The Basin Plan amendment will include an implementation plan to reduce mercury loading into Clear Lake. For additional information, refer to the *Clear Lake Mercury Basin Plan Amendment Staff Report* and *Clear Lake Total Maximum Daily Load for Mercury Final Report*.

**IX. Surrounding land uses and setting: Briefly describe the project's surroundings:**
The region affected by this amendment is Clear Lake and its surrounding watershed. Land uses within the Clear Lake watershed include residential, commercial, agricultural, light industry, and open space. The region has both public and private lands and there are five Native American Tribes within the watershed. Clear Lake has a surface area of 43,000 acres and supports both commercial and sport fisheries. For additional information, refer to the *Clear Lake Mercury Basin Plan Amendment Staff Report* and *Clear Lake Total Maximum Daily Load for Mercury Final Report*.

**X. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)**
State Water Resources Control Board
Office of Administrative Law
U.S. Environmental Protection Agency

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

| | | | | | |
|---|---|---|---|---|---|
| | Aesthetics | | Agriculture Resources | | Air Quality |
| | Biological Resources | | Cultural Resources | | Geology /Soils |
| | Hazards & Hazardous Materials | | Hydrology / Water Quality | | Land Use / Planning |
| | Mineral Resources | | Noise | | Population / Housing |
| | Public Services | | Recreation | | Transportation/Traffic |
| | Utilities / Service Systems | | Mandatory Findings of Significance | | |

### 7.1 Determination

(To be completed by the Lead Agency)
On the basis of this initial evaluation:

| | |
|---|---|
| X | I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared. |
| | I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared. |
| | I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required. |
| | I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed. |
| | I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required. |

Signature ______________________ Date ______________________

Jerrold A. Bruns, Environmental Program Manager
Printed Name

### 7.2 Evaluation of Environmental Impacts

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant With Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program Environmental Impact Report (EIR), or other California Environmental Quality Act (CEQA) process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:
   a) Earlier Analysis Used. Identify and state where they are available for review.
   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.
   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:
   a) the significance criteria or threshold, if any, used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance

## 7.3 Issues and Discussion

| | **Potentially Significant Impact** | **Less Than Significant with Mitigation Incorporation** | **Less Than Significant Impact** | **No Impact** |
|---|---|---|---|---|
| I. AESTHETICS -- Would the project: | | | | |
| a) Have a substantial adverse effect on a scenic vista? | | | | X |
| b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway? | | | | X |
| c) Substantially degrade the existing visual character or quality of the site and its surroundings? | | | | X |
| d) Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area? | | | | X |
| | | | | |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project: | | | | |
| a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use? | | | | X |
| b) Conflict with existing zoning for agricultural use, or a Williamson Act contract? | | | | X |
| c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use? | | | | X |
| | | | | |
| III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project: | | | | |
| a) Conflict with or obstruct implementation of the applicable air quality plan? | | | | X |
| b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions, which exceed quantitative thresholds for ozone precursors)? | | | | X |
| d) Expose sensitive receptors to substantial pollutant concentrations? | | | | X |
| e) Create objectionable odors affecting a substantial number of people? | | | | X |
| | | | | |
| IV. BIOLOGICAL RESOURCES – Would the project: | | | | |
| a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service? | | | X | |
| b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service? | | | X | |
| c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means? | | | | X |
| d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance? | | | | X |
| f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional or state habitat conservation plan? | | | | X |
| | | | | |
| V. CULTURAL RESOURCES -- Would the project: | | | | |
| a) Cause a substantial adverse change in the significance of a historical resource as defined in 15064.5? | | | | X |
| b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to 15064.5? | | | | X |
| c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature? | | | | X |
| d) Disturb any human remains, including those interred outside of formal cemeteries? | | | | X |
| | | | | |
| VI. GEOLOGY AND SOILS -- Would the project: | | | | |
| a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: | | | | |
| i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42. | | | | X |
| ii) Strong seismic ground shaking? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| iii) Seismic-related ground failure, including liquefaction? | | | | X |
| iv) Landslides? | | | | X |
| b) Result in substantial soil erosion or the loss of topsoil? | | | | X |
| c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse? | | | | X |
| d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property? | | | | X |
| e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater? | | | | X |
| | | | | |
| VII. HAZARDS AND HAZARDOUS MATERIALS Would the project: | | | | |
| a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials? | | | X | |
| b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment? | | | | X |
| c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment? | | | | X |
| e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area? | | | | X |
| f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area? | | | | X |
| g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan? | | | | X |
| h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands? | | | | X |
| | | | | |
| VIII. HYDROLOGY AND WATER QUALITY -- Would the project: | | | | |
| a) Violate any water quality standards or waste discharge requirements? | | | X | |
| b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site? | | | | X |
| d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site? | | | | X |
| e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff? | | | | X |
| f) Otherwise substantially degrade water quality? | | | | X |
| g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map? | | | | X |
| h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows? | | | | X |
| i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam? | | | | X |
| j) Inundation by seiche, tsunami, or mudflow? | | | | X |
| | | | | |
| IX. LAND USE AND PLANNING - Would the project: | | | | |
| a) Physically divide an established community? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect? | | | X | |
| c) Conflict with any applicable habitat conservation plan or natural community conservation plan? | | | | X |
| | | | | |
| X. MINERAL RESOURCES -- Would the project: | | | | |
| a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state? | | | | X |
| b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan? | | | | X |
| | | | | |
| XI. NOISE Would the project result in: | | | | |
| a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies? | | | | X |
| b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels? | | | | X |
| c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project? | | | | X |
| d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels? | | | | X |
| f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels? | | | | X |
| | | | | |
| XII. POPULATION AND HOUSING -- Would the project: | | | | |
| a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)? | | | | X |
| b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere? | | | | X |
| c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere? | | | | X |
| | | | | |
| XIII. PUBLIC SERVICES | | | | |
| a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services: | | | | X |
| Fire protection? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| Police protection? | | | | X |
| Schools? | | | | X |
| Parks? | | | | X |
| Other public facilities? | | | X | |
| | | | | |
| XIV. RECREATION -- | | | | |
| a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated? | | | | X |
| b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment? | | | | X |
| | | | | |
| XV. TRANSPORTATION/TRAFFIC -- Would the project: | | | | |
| a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)? | | | | X |
| b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways? | | | | X |
| c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks? | | | | X |

| | Potentially Significant Impact | Less Than Significant with Mitigation Incorporation | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)? | | | | X |
| e) Result in inadequate emergency access? | | | | X |
| f) Result in inadequate parking capacity? | | | | X |
| g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)? | | | | X |
| | | | | |
| XVI. UTILITIES AND SERVICE SYSTEMS Would the project: | | | | |
| a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board? | | | | X |
| b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects? | | | | X |
| c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects? | | | X | |
| d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed? | | | | X |
| e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the projects projected demand in addition to the providers existing commitments? | | | | X |

| | **Potentially Significant Impact** | **Less Than Significant with Mitigation Incorporation** | **Less Than Significant Impact** | **No Impact** |
|---|---|---|---|---|
| f) Be served by a landfill with sufficient permitted capacity to accommodate the projects solid waste disposal needs? | | | | X |
| g) Comply with federal, state, and local statutes and regulations related to solid waste? | | | | X |
| | | | | |
| XVII. MANDATORY FINDINGS OF SIGNIFICANCE -- | | | | |
| a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory? | | | | X |
| b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)? | | | X | |
| c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly? | | | | X |

## Discussion of Environmental Impacts

### I. Aesthetics

The proposed project establishes water quality objectives for mercury in fish tissue and implements a water quality management strategy for mercury in Clear Lake. Establishment of water quality objectives will have no direct impact on the aesthetics of the Clear Lake area. The proposed addition of the commercial and sport fishing(COMM) beneficial use for Clear Lake will have no impact on aesthetics. While the proposed project itself will not cause a change in aesthetics, responsible parties complying with mercury load reductions may alter the aesthetics depending on their respective projects. For example, the implementation plan requires a reduction in mercury loading from the owners of the Sulphur Bank Mercury Mine (SBMM). The USEPA is performing remediation activities at SBMM under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). USEPA may select a project which alters the aesthetics of the abandoned mine. USEPA will determine environmental compliance of any proposed remediation projects at that time.

### II. Agriculture Resources

The proposed Basin Plan amendment and implementation of a mercury water quality management plan itself will not prescribe changes to agricultural resources. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on agricultural resources. The project will recommend that appropriate State, federal, and local agencies form a partnership to evaluate sources of mercury in tributaries to Clear Lake and to reduce mercury loads. It is currently unknown if local agricultural practices contribute to erosion of soils with elevated mercury concentrations. If the partnership, through their watershed studies, determines that grazing or other agricultural practices cause significant erosion of soils containing elevated mercury concentrations, the use of best management practices for agricultural activities may be needed to reach the load reduction goals.

### III. Air Quality

The proposed Basin Plan amendment and mercury water quality management plan will have no direct impact on air quality. The long-term goal of this project is to reduce mercury loading in the local environment, including water and air. The net benefit should be an improvement in air quality with respect to airborne mercury. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on air quality.

The water quality management implementation plan will request that the USEPA prepare and implement a plan to reduce mercury loading to Clear Lake from SBMM. Covering of mine waste piles will likely reduce mercury emissions to the atmosphere. Remediation activities may involve construction and large earth moving equipment. There may be short-term, localized increases in air pollutants due to particulates and emissions generated from construction equipment. In addition, there may be dust created as waste materials are loaded onto trucks, transported, and disposed within the Sulphur Bank Mine property. It is expected that contractors working under guidance of the USEPA Superfund Program will implement dust control measures. The USEPA is anticipated to analyze the effects of their projects on the environment and to provide mitigation measures as necessary.

## IV. Biological Resources

The proposed Basin Plan amendment and water quality management implementation plan for mercury will not adversely impact biological resources. The goal of the water quality management implementation plan is to reduce the overall loading of mercury to Clear Lake, which should result in a benefit to biological resources. The amendment is designed to reduce mercury in fish and thus biological resources that consume fish will be beneficially impacted by the amendment. The water quality management plan report found that it is necessary to reduce the mercury concentration in trophic levels 3 and 4 fish tissue by 70% to be protective for fish consumers, including wildlife that eat fish from Clear Lake. Reduction of mercury in fish tissue will benefit species that are potentially at risk due to mercury contamination. Through the implementation plan, the loads of mercury from various sources will be reduced. Any construction or other activities planned to reduce mercury that affect wildlife habitats will be evaluated for environmental impacts prior to initiation by respective agencies.

The U.S. Fish and Wildlife Service (USFWS) has reviewed the Clear Lake TMDL report and the Target Report. USFWS recommended that the Clear Lake methylmercury water quality objects be established at 0.09 and 0.19 mg/kg (wet weight) for trophic level (TL) 3 and TL4 fish, respectively. USFWS considers reductions in TL3 and TL4 to these methylmercury levels, and the corresponding reduction in TL2 fish concentrations, to be protective of sensitive species of wildlife, including bald eagle and osprey.

Regional Water Board staff does not anticipate that any activities conducted in response to the proposed implementation plan will have significant adverse effects on species of special status or on riparian or other sensitive natural communities. If lakebed sediments are dredged or otherwise disturbed, it is likely that these activities would occur over a relatively small area (maximum area estimated to be 270 acres, which is 0.6% of the total lakebed). Disturbance would occur temporarily as sediments are removed or capped. Capping material would be selected that would allow the lakebed habitat and benthic communities to be reestablished.

Wetlands typically have greater net production of methylmercury than the open water of a lake or stream. However, wetlands are desired in the Clear Lake basin for sediment retention and wildlife habitat. The Regional Water Board is setting a goal of no significant increases in methylmercury loads to Clear Lake beyond existing levels. This goal applies to any wetlands, riparian, floodplain restoration, or similar activities in the Clear Lake watershed. Proposals for wetland restoration or similar activities should assess the potential for the project to produce methylmercury. Design plans for wetlands or floodplain restoration may need to be revised to limit the production of methylmercury. Possible design adjustments to satisfy the Regional Water Board goal might include limiting the amount of area flooded during peak methylation periods.

The U.S. Army Corps of Engineers is the lead agency for the development of the Middle Creek Ecosystem Restoration Project. The project would be located in the Rodman Slough area on the northern perimeter of the Upper Arm of Clear Lake. The project is intended to restore habitat and the natural sediment retention and flood control functions that existed before the project area was channelized, leveed and much of the area used for agricultural purposes (Jones & Stokes

Associates, 1997). A feasibility report for the project was released in Spring of 2002. The riparian area along Rodman Slough, Scott's Creek and Middle Creek is identified as a regionally significant wildlife resource. This type of habitat is expected to be increased if the project is completed. Completion of the project would also achieve the reductions in mercury loads that are required in the Basin Plan amendment through sediment retention. Regional Water Board staff will continue to work with the involved agencies during planning and implementation of the Middle Creek project to address concerns over methylmercury production.

Remediation activities will occur on the SBMM site that may adversely affect species of special status on the mine site. These effects are not expected to have a significant impact. As the natural resource trustees for the site, the U.S. Fish and Wildlife Service should be consulted in the planning and implementation of remediation on the site, so that mitigation is provided for any adverse effects on special status species.

The proposed addition of the commercial and sport fishing (COMM) beneficial use will not impact biological resources. Commercial and sport fishing are a past and present uses of Clear Lake. The California Department of Fish and Game issues commercial and sport fishing licenses for commercial harvest of fish and sport fishing licenses for recreation and tournament permits for use in Clear Lake.
The addition of this designation will not conflict with existing local policies or ordinances.

## V. Cultural Resources

The Basin Plan amendment and the water quality management implementation plan for mercury will not directly affect cultural resources. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on cultural resources. Any implementation activities to reduce mercury loading that involve land disturbance will undergo environmental review (under CEQA or the National Environmental Policy Act (NEPA)) and will be evaluated on an individual basis as needed. The implementation plan will request that the USEPA Superfund Program conduct remediation activities at the Sulphur Bank Mercury Mine. USEPA's activities may include disturbance and removal of mine structures and wastes, and may remove geologic features that were a result of mining activities.

**VI. Geology and Soils**

The proposed Basin Plan amendment and the water quality management implementation plan for mercury addresses water quality issues and will not directly impact local geology and soils. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on geology and soils. The proposed implementation plan requires that mercury inputs from the Clear Lake watershed be controlled to reduce mercury loading to the lake. Some mercury load reduction may be realized through a reduction in erosion of mercury contaminated soils from areas used for grazing or other agricultural practices. There is potential that the remediation activities at Sulphur Bank Mercury Mine (e.g., consolidate and cover waste piles) may result in minor soil erosion and the loss of topsoil during construction. As part of USEPA's remediation activities on the mine site, the mine wastes will likely be covered with topsoil and vegetated. The topsoil has the potential to erode if vegetation does not become established and mature before winter and spring rains. Under the Superfund Program, USEPA will implement erosion control measures and provide any necessary mitigation for erosion during remedia tion on the SBMM site.

**VII. Hazards and Hazardous Materials**

The proposed Basin Plan amendment and the water quality management implementation plan for mercury address water quality issues and will not directly effect the handling or transport of hazards and hazardous materials. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on hazards or hazardousmaterials. The amendment will not regulate hazards or hazardous materials. The site with the most significant amount of hazards is the Sulphur Bank Mercury Mine. The site is fenced and closed to the public. The USEPA is planning remediation activities on the site under CERCLA. During remediation activities, wastes containing high concentrations of mercury may be exposed to sensitive receptors. There will be human and environmental exposure to these wastes during the excavation, transport, and disposal of the mine wastes. Remediation agencies will take measures to protect workers during construction activities. Dust control measures will minimize exposure. At completion of the Sulphur Bank remediation project, mine wastes will be covered or removed and long term human and environmental exposure will be minimized.

**VIII. Hydrology and Water Quality**

The proposed project amends the Basin Plan to establish water quality objectives (mercury concentrations in fish tissue). Currently, Clear Lake is on the federal Clean Water Act 303(d) list of impaired waterbodies due to elevated concentrations of mercury in fish tissue. The proposed project contains an implementation plan to reduce mercury loading into Clear Lake, therefore reducing the concentration in fish tissue. In the long term, mercury concentrations should be reduced and water quality standards met.

The proposed implementation plan contains a monitoring plan. The monitoring plan will measure whether mercury loads have been reduced to meet water quality objectives. Monitoring will include fish tissue, water, and sediment sampling. Total mercury in tributary sediment, lake sediment, and water will be monitored to determine whether loads have decreased.

To achieve the load reductions described in the implementation plan, dredging may be performed on a small portion of the lakebed. Dredging would likely result in localized, temporary violations of water quality standards. Standards for turbidity, concentrations of mercury, and possibly concentrations of other minerals could be exceeded. The violations are expected to have limited impact on water quality.

The proposed project will not have a direct effect on groundwater supplies or recharge. As part of remediation activities at Sulphur Bank Mercury Mine, the USEPA may propose to substantially reduce the flow of mercury contaminated groundwater from the Herman Impoundment to Clear Lake. This groundwater flow is very localized and should not significantly affect the local groundwater table. During remediation activities or after remediation is completed, waste discharge requirements are not expected to be violated.

The proposed project will not have a direct effect on surface water drainage patterns, change the course of streams or rivers, cause increased erosion or siltation, or result in flooding the Clear Lake watershed. The mercury water quality management implementation plan requests that USEPA to evaluate sources of mercury and reduce erosion of mercury contaminated sediment from the Sulphur Bank, therefore improving water quality. Sulphur Bank Mercury Mine remediation activities may alter surface water flows if USEPA elects to divert storm water from mine features and waste piles. The implementation plan also requires an evaluation and reduction of mercury loads from Clear Lake tributaries. The goal of the tributary work is to reduce the erosion of soils containing elevated concentrations of mercury. Proponents of mine remediation or erosion control projects will evaluate impacts to hydrology and water quality prior to implementing any remediation activities.

The proposed addition of the COMM beneficial use for Clear Lake will have no impact on hydrology or water quality. Commercial and sport fishing are a past and present use of Clear Lake.

## IX. Land Use and Planning

The proposed Basin Plan amendment regulates water quality and does not directly effect land use and planning. However, implementation of the amendment will require a reduction of mercury loads to Clear Lake. State, federal and local agencies will be responsible for identifying and reducing loads from areas that have elevated concentrations of mercury. While it is not known at this time which methods will be used to reduce mercury loads from Clear Lake's tributaries, it may be possible that land uses may be modified to reduce erosion of mercury contaminated sediment. Land uses that might be affected by this project could include agriculture, grazing, and construction activities at areas with elevated mercury concentration. Likely land use modifications could be application of best management practices to reduce erosion caused by grazing and reduction of erosion from road and other construction sites.

Several wetlands and stream bank restoration activities are planned in the Clear Lake watershed. To comply with the Regional Water Board's goal of no significant methylmercury loading from these types of projects, planners should assess the potential for the project to produce methylmercury. The Regional Water Board does not expect that intentions of land use or location of these or similar projects would be altered unless methylmercury loading to Clear Lake is anticipated to be significantly increased. Regional Water Board staff will work with restoration project planners to minimize methylmercury production.

The proposed addition of the COMM beneficial use for Clear Lake will have no impact on land use and planning.

**X. Mineral Resources**

The proposed project addresses water quality and control of mercury contamination and will not directly impact mineral resources. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on mineral resources. There are several mercury mines in the Clear Lake region, however, none of the mines is active and there are no known plans for mercury exploration or mercury mining operations.

**XI. Noise**

The proposed project addresses water quality and control of mercury contamination and will not directly cause an increase in noise levels. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on noise. Remediation activities at the Sulphur Bank Mercury Mine will generate noise during any construction activities. The USEPA is planning remediation activities under the Superfund Program. Noise will emanate from the excavation, transportation, disposal of the mine wastes, and other earth moving activities. The noise impacts would be temporary and would only occur during daylight hours during active construction. Under CERCLA, the USEPA will determine the environmental compliance of any proposed remediation projects at that time.

**XII. Population and Housing**

The proposed Basin Plan amendment and mercury water quality management implementation plan will not directly affect population and housing. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on population and housing. It is not anticipated that reduction of mercury loads will displace housing or generate population growth.

**XIII. Public Services**

The proposed Basin Plan amendment and implementation plan for mercury water quality management will not result in physical alteration of government facilities or adverse physical impacts from construction of new government facilities. Other impacts on public services would be less than significant. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on public services.

Until beneficial uses are attained in Clear Lake, the implementation plan requires that the public be informed of safe fish consumption levels and the risks of mercury in Clear Lake. The Lake County Public Health Department is named as the lead agency in this effort. Possible public education activities include posting of permanent signs at public boat launches on Clear Lake, preparation and distribution of a flier detailing safe exposure levels, and outreach at public events. Resources or funds to offset costs to Lake County may be available from the California Department of Health Services.

Reduction of mercury loading sources in Clear Lake tributaries may require Lake County and other governmental agencies to provide resources for evaluation and remediation of mercury hotspots within the Clear Lake watershed. It is expected that most of the required reductions will be accomplished through control of erosion. Erosion control is a goal of the Lake County and local watershed groups to address water quality concerns in addition to mercury.

## XIV. Recreation

The proposed Basin Plan amendment and the water quality management implementation plan for mercury will not directly affect recreational activities. There are no known recreational facilities that would be adversely affected by mercury reduction activities. A major benefit from the project would be increased recreational fishing and consumption of sport fish from Clear Lake if the fish had lower mercury concentrations. There is currently a fish consumption advisory for Clear Lake fish warning consumers to limit the quantity of fish consumed from the lake. Lower fish tissue mercury concentrations would allow anglers to keep and consume more locally caught fish.

Publicity regarding the fish consumption advisory and designation of Clear Lake as impaired due to mercury have negatively impacted tourism and fishing in the Clear Lake basin. It is expected that reducing mercury in Clear Lake will improve public opinion of Clear Lake as a recreation site.

The proposed addition of the COMM beneficial use for Clear Lake will have no impact on recreation. Commercial and sport fishing are a past and present use of Clear Lake.

## XV. Transportation/Traffic

The proposed Basin Plan amendment and implementation plan will not directly affect transportation facilities. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on transportation or traffic. Remediation activities at Sulphur Bank Mercury Mine will generate truck traffic during construction phases. Traffic impacts during remediation would be temporary and localized either onsite (for relocating waste rock) or on highways and access roads to the site (for bringing construction equipment and materials). As noted for recreational impacts (above), there may be an increase in tourist and local traffic if Clear Lake fishing conditions improve.

## XVI. Utilities and Service Systems

The Basin Plan amendment and mercury water quality management implementation plan will not directly affect utility and service systems. The proposed addition of the COMM beneficial use for Clear Lake will have no impact on utilities or services systems. However, as part of mercury load reductions into Clear Lake tributaries, local government agencies may determine that storm water drainage facilities may need expansion or improvement to divert storm water from mercury hotspots within the watershed. Lake County or property owners may consider building storm water retention basins to collect mercury contaminated sediment. The Basin Plan amendment and implementation plan will have no impact on existing wastewater treatment systems.

## XVII. Mandatory Findings of Significance

The proposed Basin Plan amendment and implementation plan provide regulatory guidance for mercury reduction in the environment. The amendment does not prescribe the means or methods for the various sources to reduce their respective mercury loads to Clear Lake. The local, State, and federal agencies and respective landowners will make the decisions to determine methods of compliance. Likely implementation activities are described in Section 5 of this report. The environmental analysis did not find any direct significant impacts from the proposed project that would cause degradation of the environment or cause adverse effects on human beings. The environmental analysis also concludes that there would be no indirect, significant adverse impacts resulting from the proposed Basin Plan amendment and implementation plan.

Adoption of the Basin Plan amendment and implementation plan will not in-itself have a physical effect on the environment. However, actions taken by other agencies to comply with the proposed implementation plan may effect the environment. Those agencies will be required to develop and adhere to their respective environmental documents under CEQA, NEPA and/or CERCLA.

## 7.4 De Minimus Finding

The Regional Water Board staff, after consideration of the evidence, recommends that the Regional Water Board find that the proposed project has no potential for adverse effect, either individually or cumulatively, on wildlife or the environment.

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# APPENDIX A. MERCURY CONCENTRATIONS IN FISH FROM CLEAR LAKE

The following data (Tables A1 through A3) were used to determine the baseline for concentrations of methylmercury in fish from Clear Lake. Sources of data were: individual laboratory reports from the California Department of Fish and Game (CDFG, 1983; CDFG, 1984a; CDFG, 1984b; CDFG, 1984c; CDFG, 1984e); the U.S. Food and Drug Administration (USFDA, 1976); compilations of data from the Regional Water Board (CVRWQCB, 1985) and California Department of Health Services (Stratton et al., 1987); the State Water Resources Control Board (Rasmussen, 1993); and the University of California Davis Clear Lake Environmental Research Center (UCD CLERC) (Suchanek et al., 1997; Suchanek et al., 1993). Unpublished data from UCD CLERC are presented here as well. Data from these sources were combined for statistical analysis. All data reported are for mercury per wet weight in edible tissue.

In 1970 CDHS collected and analyzed two composite fish samples from Clear Lake, one largemouth bass sample and one white catfish sample, each a composite of ten fish. This analysis provided the first indication that fish from Clear Lake might contain excessive levels of mercury (CVRWQCB, 1985). The USFDA analyzed additional fish-tissue samples in 1976. The Toxic Substances Monitoring Program of the State Water Resources Control Board then collected and analyzed fish samples from 1980 to 1984 (Rasmussen, 1993). Between 1970 and 1984, more than 400 fish samples from Clear Lake were analyzed for mercury. Species tested included largemouth bass, channel catfish, white catfish, brown bullhead, white and black crappie, bluegill, carp, hitch, Sacramento blackfish and inland silverside. Most data were reported for individual fish, although some data were reported for composite samples. All data reported were for mercury per wet weight in edible tissue. UCD CLERC collected and analyzed fish from Clear Lake between 1992 and 2000. Part of the sampling by UC Davis was conducted under contract with USEPA.

Concentrations of mercury in fish are, in general, not significantly different between the arms of the lake (Suchanek et al., 1997). Analysis of juvenile largemouth bass and inland silversides caught in 1998 and 1999 showed no decline in mercury concentrations, as compared to 1970-1984 mercury concentrations (Suchanek et al., 2000). Regional Water Board staff also evaluated the fish tissue data presented here and found no trends or changes in mercury concentrations over time. Therefore, all data were combined to determine baseline concentrations.

Table A-1. Mercury Concentrations in Clear Lake Fish Species

| Fish Species | inland silverside | juvenile largemouth bass | bluegill | hitch | carp | black bullhead | Sacramento blackfish | brown bullhead |
|---|---|---|---|---|---|---|---|---|
| Mean (mg/kg wet wt) | 0.09 | 0.18 | 0.19 | 0.19 | 0.20 | 0.22 | 0.28 | 0.28 |
| Standard Deviation | 0.03 | 0.04 | 0.20 | 0.13 | 0.17 | 0.09 | 0.10 | 0.11 |

| Fish Species | black crappie | white crappie | channel catfish | white catfish | largemouth bass | | | |
|---|---|---|---|---|---|---|---|---|
| Mean (mg/kg wet wt) | 0.36 | 0.48 | 0.46 | 0.48 | 0.54 | | | |
| Standard Deviation | 0.19 | 0.36 | 0.34 | 0.19 | 0.32 | | | |

Sources: CVRWQCB, 1985; Suchanek et al., 1993; Suchanek et al., 1997; and unpublished data from the UC Davis Clear Lake Environmental Research Center regarding channel catfish data, 2000. Data was checked against CDF&G laboratory reports when available. Raw data is displayed in Table A-3.

Table A-2. Baseline Concentrations for Evaluating Compliance with the Basin Plan Water Quality Objectives

| | Average Concentration of trophic level 3 fish includes: bluegill, hitch, carp, Sacramento blackfish and black bullhead and catfish and brown bullhead less than 250 mm total length. Units: mg methylmercury/kg edible fish tissue, wet weight. (a) | Average concentration of trophic level 4 fish includes: black crappie and white crappie longer than 175 mm total length; brown bullhead, white catfish and channel catfish 250-600 mm; and largemouth bass 310-450 mm total length. Units: mg methylmercury/kg edible fish tissue, wet weight. (b) |
|---|---|---|
| **Mean** | 0.22 | 0.46 |
| **Standard Deviation** | 0.13 | 0.27 |

(a) Small catfish and brown bullhead are categorized as TL3 fish because of probable prey consumed by these sizes of fish. Although data are available on mercury concentrations in largemouth bass below the legal size limit, these data were not used to establish the baselines.

(b) The average concentration used for as the Basin Plan Amendment baseline is slightly less than the average concentration of trophic level 4 fish used in the Clear Lake Mercury Numeric Target Report to determine existing conditions and water quality objectives (CVRWQCB, 2001; 0.50 mg/kg). The determination of existing conditions used all fish tissue data available, which included mercury concentrations in largemouth bass and catfish both larger and smaller than the length ranges used for the Basin Plan Amendment Baseline. Creel survey data indicates that trophic level 4 fish beyond the size ranges above are caught and likely consumed (Macedo, 1991). Smaller size ranges are presented in the proposed water quality objectives in order to standardize monitoring and to facilitate assessment of compliance with the water quality objectives.

| Table A-3 Raw Data for Mercury Concentrations in Clear Lake Fish | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| CDFG | Feb-80 | Brown bullhead | 2 | 139 | 229 | Oaks | 0.2 |
| CDFG | Feb-80 | Brown bullhead | 2 | 318 | 293 | Oaks | 0.25 |
| CDFG | Mar-80 | Brown bullhead | 1 | 395 | 320 | Oaks | 0.58 |
| CDFG | Apr-80 | Brown bullhead | 1 | 133 | 220 | Oaks | 0.12 |
| CDFG | Apr-80 | Brown bullhead | 1 | 428 | 340 | Oaks | 0.2 |
| CDFG | May-80 | Brown bullhead | 2 | 468 | 320 | Upper | 0.22 |
| CDFG | Jun-88 | Brown bullhead | 1 | 707 | 344 | Oaks | 0.3 |
| CDFG | Jun-88 | Brown bullhead | 1 | 354 | 271 | Oaks | 0.19 |
| CDFG | Jun-88 | Brown bullhead | 1 | 581 | 334 | Oaks | 0.27 |
| CDFG | Jun-88 | Brown bullhead | 1 | 455 | 313 | Oaks | 0.26 |
| CDFG | Jun-88 | Brown bullhead | 1 | 458 | 308 | Oaks | 0.22 |
| CDFG | Jun-88 | Brown bullhead | 1 | 461 | 303 | Oaks | 0.26 |
| CDFG | Jun-88 | Brown bullhead | 1 | 672 | 337 | Oaks | 0.42 |
| CDFG | Jun-88 | Brown bullhead | 1 | 369 | 284 | Oaks | 0.34 |
| CDFG | Jun-88 | Brown bullhead | 1 | 723 | 358 | Oaks | 0.54 |
| CDFG | Jun-88 | Brown bullhead | 1 | 724 | 347 | Oaks | 0.38 |
| CDFG | Jun-88 | Brown bullhead | 1 | 224 | 241 | Oaks | 0.13 |
| CDFG | Jun-88 | Brown bullhead | 1 | 424 | 310 | Oaks | 0.24 |
| CDFG | Jun-88 | Brown bullhead | 1 | 576 | 330 | Oaks | 0.24 |
| CDFG | Jun-88 | Brown bullhead | 1 | 688 | 347 | Oaks | 0.32 |
| CDFG | Jun-88 | Brown bullhead | 1 | 629 | 351 | Oaks | 0.2 |
| CDFG | Jun-88 | Brown bullhead | 1 | 432 | 312 | Oaks | 0.31 |
| CDFG | Jun-88 | Brown bullhead | 1 | 454 | 322 | Oaks | 0.26 |
| CDFG | Jun-88 | Brown bullhead | 1 | 512 | 323 | Oaks | 0.14 |
| CDFG | Jun-88 | Brown bullhead | 1 | 487 | 328 | Oaks | 0.24 |
| CDFG | Jun-88 | Brown bullhead | 1 | 453 | 309 | Oaks | 0.24 |
| CDFG | Feb-80 | Black crappie | 4 | 119 | 195 | Oaks | 0.24 |
| CDFG | Feb-80 | Black crappie | 2 | 185 | 224 | Oaks | 0.28 |
| CDFG | Mar-80 | Black crappie | 3 | 198 | 224 | Oaks | 0.16 |
| CDFG | Apr-80 | Black crappie | 1 | 170 | 220 | Oaks | 0.07 |
| CDFG | May-80 | Black crappie | 4 | 154 | 210 | Upper | 0.18 |
| CDFG | Aug-87 | Black crappie | 1 | 169 | 205 | Upper | 0.23 |
| CDFG | Aug-87 | Black crappie | 1 | 186 | 209 | Upper | 0.16 |
| CDFG | Aug-87 | Black crappie | 1 | 270 | 242 | Upper | 0.28 |
| CDFG | Feb-88 | Black crappie | 1 | 610 | 292 | Upper | 0.29 |
| CDFG | Feb-88 | Black crappie | 1 | 982 | 345 | Upper | 0.59 |
| CDFG | Feb-88 | Black crappie | 1 | 673 | 304 | Upper | 0.3 |
| CDFG | Feb-88 | Black crappie | 1 | 612 | 286 | Upper | 0.4 |
| CDFG | Feb-88 | Black crappie | 1 | 784 | 308 | Upper | 0.43 |
| CDFG | Feb-88 | Black crappie | 1 | 595 | 292 | Upper | 0.69 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| CDFG | Feb-88 | Black crappie | 1 | 731 | 302 | Upper | 0.66 |
| CDFG | Feb-88 | Black crappie | 1 | 723 | 298 | Upper | 0.81 |
| CDFG | Feb-88 | Black crappie | 1 | 510 | 275 | Upper | 0.3 |
| CDFG | Feb-88 | Black crappie | 1 | 561 | 273 | Upper | 0.34 |
| CDFG | Feb-88 | Black crappie | 1 | 614 | 299 | Upper | 0.49 |
| CDFG | Feb-88 | Black crappie | 1 | 501 | 270 | Upper | 0.46 |
| CDFG | Feb-88 | Black crappie | 1 | 612 | 290 | Upper | 0.4 |
| CDFG | Feb-88 | Black crappie | 1 | 454 | 270 | Upper | 0.32 |
| CDFG | Feb-88 | Black crappie | 1 | 549 | 283 | Upper | 0.46 |
| CDFG | Feb-88 | Black crappie | 1 | 161 | 192 | Upper | 0.36 |
| CDFG | Feb-88 | Black crappie | 1 | 150 | 193 | Upper | 0.27 |
| CDFG | Feb-88 | Black crappie | 1 | 526 | 280 | Upper | 0.49 |
| CDFG | Feb-88 | Black crappie | 1 | 815 | 284 | Upper | 0.57 |
| CDFG | Feb-88 | Black crappie | 1 | 359 | 248 | Upper | 0.34 |
| CDFG | Jun-88 | Black crappie | 1 | 116 | 184 | Oaks | 0.33 |
| CDFG | Jun-88 | Black crappie | 1 | 158 | 208 | Oaks | 0.36 |
| CDFG | Jun-88 | Black crappie | 1 | 156 | 198 | Oaks | 0.41 |
| CDFG | Jun-88 | Black crappie | 1 | 110 | 188 | Oaks | 0.43 |
| CDFG | Jun-88 | Black crappie | 1 | 133 | 194 | Oaks | 0.37 |
| CDFG | Jun-88 | Black crappie | 1 | 138 | 200 | Oaks | 0.33 |
| CDFG | Jun-88 | Black crappie | 1 | 114 | 191 | Oaks | 0.28 |
| CDFG | Jun-88 | Black crappie | 1 | 83 | 174 | Oaks | 0.66 |
| CDFG | Jun-88 | Black crappie | 1 | 99 | 180 | Oaks | 0.62 |
| CDFG | Jun-88 | Black crappie | 1 | 118 | 187 | Oaks | 0.17 |
| CDFG | Jun-88 | Black crappie | 1 | 104 | 182 | Oaks | 0.55 |
| CDFG | Jun-88 | Black crappie | 1 | 132 | 190 | Oaks | 0.29 |
| CDFG | Jun-88 | Black crappie | 1 | 125 | 197 | Oaks | 0.22 |
| CDFG | Jun-88 | Black crappie | 1 | 134 | 194 | Oaks | 0.46 |
| CDFG | Jun-88 | Black crappie | 1 | 142 | 202 | Oaks | 0.35 |
| CDFG | Jun-88 | Black crappie | 1 | 482 | 284 | Oaks | 0.57 |
| CDFG | Feb-80 | Bluegill | 3 | 94 | 159 | Oaks | 0.47 |
| CDFG | Mar-80 | Bluegill | 2 | 47 | 124 | Oaks | 0.04 |
| CDFG | Mar-80 | Bluegill | 1 | 155 | 184 | Oaks | 0.19 |
| CDFG | May-80 | Bluegill | 2 | 94 | 150 | Upper | 0.06 |
| CDFG | Aug-87 | Black bullhead | 1 | | 309 | Upper | 0.18 |
| CDFG | Aug-87 | Black bullhead | 1 | 466 | 315 | Upper | 0.15 |
| CDFG | Aug-87 | Black bullhead | 1 | 504 | 320 | Upper | 0.37 |
| CDFG | Aug-87 | Black bullhead | 1 | 567 | 325 | Upper | 0.12 |
| CDFG | Aug-87 | Black bullhead | 1 | 542 | 336 | Upper | 0.24 |
| CDFG | Aug-87 | Black bullhead | 1 | 661 | 343 | Upper | 0.28 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| FDA | Mar-80 | Carp | 1 | | | | 0.44 |
| FDA | Mar-80 | Carp | 1 | | | | 0.54 |
| FDA | Mar-80 | Carp | 1 | | | | 0.6 |
| CDFG | Mar-80 | Carp | 1 | 1710 | 435 | Oaks | 0.13 |
| CDFG | Mar-80 | Carp | 1 | 1626 | 422 | Oaks | 0.2 |
| CDFG | Mar-80 | Carp | 1 | 1176 | | Oaks | 0.07 |
| UCD | 1992 | Carp | 1 | 1814 | | Oaks | 0.05 |
| UCD | 1992 | Carp | 4 | 3642 | | Oaks | 0.1 |
| UCD | 1992 | Carp | 4 | 4635 | | Oaks | 0.21 |
| UCD | 1992 | Carp | 3 | 5625 | | Oaks | 0.4 |
| UCD | 1992 | Carp | 1 | 1645 | | Oaks | 0.05 |
| UCD | 1992 | Carp | 1 | 4374 | | Oaks | 0.13 |
| UCD | 1992 | Carp | 3 | 3272 | | Lower | 0.22 |
| UCD | 1992 | Carp | 4 | 3791 | | Lower | 0.1 |
| UCD | 1992 | Carp | 3 | 5021 | | Lower | 0.05 |
| UCD | 1992 | Carp | 1 | 7567 | | Lower | 0.05 |
| UCD | 1992 | Carp | 1 | 3787 | | Upper | 0.13 |
| UCD | 1992 | Carp | 1 | 4042 | | Upper | 0.1 |
| CDFG | Aug-87 | Channel catfish | 1 | 2617 | 547 | Oaks | 0.8 |
| CDFG | Aug-87 | Channel catfish | 1 | 5234 | 619 | Oaks | 1.4 |
| CDFG | Aug-87 | Channel catfish | 1 | 5457 | 645 | Oaks | 1.4 |
| CDFG | Aug-87 | Channel catfish | 1 | 6190 | 745 | Oaks | 1.5 |
| CDFG | Feb-88 | Channel catfish | 1 | 1254 | 438 | Upper | 0.42 |
| CDFG | Feb-88 | Channel catfish | 1 | 1868 | 508 | Upper | 0.43 |
| CDFG | Feb-88 | Channel catfish | 1 | 1444 | 462 | Upper | 0.38 |
| CDFG | Feb-88 | Channel catfish | 1 | 769 | 350 | Upper | 0.2 |
| CDFG | Feb-88 | Channel catfish | 1 | 1164 | 408 | Upper | 0.38 |
| CDFG | Feb-88 | Channel catfish | 1 | 1377 | 485 | Upper | 0.68 |
| CDFG | Feb-88 | Channel catfish | 1 | 1247 | 431 | Upper | 0.24 |
| CDFG | Feb-88 | Channel catfish | 1 | 2238 | 519 | Upper | 0.45 |
| CDFG | Apr-88 | Channel catfish | 1 | 4350 | 655 | Upper | 1.3 |
| CDFG | Apr-88 | Channel catfish | 1 | 6952 | 740 | Upper | 0.9 |
| CDFG | May-88 | Channel catfish | 1 | 1411 | 451 | Oaks | 0.19 |
| CDFG | May-88 | Channel catfish | 1 | 2526 | 512 | Oaks | 0.38 |
| CDFG | May-88 | Channel catfish | 1 | 1665 | 494 | Oaks | 0.29 |
| CDFG | May-88 | Channel catfish | 1 | 7899 | 730 | Oaks | 0.28 |
| CDFG | Jun-88 | Channel catfish | 1 | 1056 | 408 | Oaks | 0.17 |
| CDFG | Jun-88 | Channel catfish | 1 | 3872 | 635 | Oaks | 0.93 |
| CDFG | Jun-88 | Channel catfish | 1 | 28 | 126 | Oaks | 0.08 |
| CDFG | Jun-88 | Channel catfish | 1 | 115 | 196 | Oaks | 0.25 |
| CDFG | Jun-88 | Channel catfish | 1 | 192 | 233 | Oaks | 0.19 |
| CDFG | Jun-88 | Channel catfish | 1 | 805 | 273 | Oaks | 0.19 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| CDFG | Jun-88 | Channel catfish | 1 | 848 | 385 | Oaks | 0.3 |
| CDFG | Jun-88 | Channel catfish | 1 | 2407 | 545 | Oaks | 0.46 |
| CDFG | Jun-88 | Channel catfish | 1 | 2218 | 518 | Oaks | 0.51 |
| CDFG | Jun-88 | Channel catfish | 1 | 5339 | 740 | Oaks | 1.2 |
| UCD | 1992 | Channel catfish | 1 | 1545 | 444.6 | Oaks | 0.1 |
| UCD | 1992 | Channel catfish | 1 | 2115 | 522.2 | Oaks | 0.1 |
| UCD | 1992 | Channel catfish | 1 | 2756 | 609.4 | Oaks | 0.38 |
| UCD | 1992 | Channel catfish | 1 | 7200 | 1214.3 | Oaks | 0.7 |
| UCD | 1992 | Channel catfish | 3 | 819 | 345.8 | Oaks | 0.1 |
| UCD | 1992 | Channel catfish | 3 | 1618 | 454.6 | Oaks | 0.14 |
| UCD | 1992 | Channel catfish | 3 | 2631 | 592.4 | Oaks | 0.23 |
| UCD | 1992 | Channel catfish | 1 | 3979 | 775.9 | Oaks | 0.46 |
| UCD | 1992 | Channel catfish | 2 | 5196 | 941.5 | Oaks | 0.33 |
| UCD | 1992 | Channel catfish | 1 | 606 | 316.8 | Lower | 0.15 |
| UCD | 1992 | Channel catfish | 3 | 2274 | 543.8 | Lower | 0.22 |
| UCD | 1992 | Channel catfish | 3 | 2823 | 618.6 | Lower | 0.24 |
| UCD | 1992 | Channel catfish | 3 | 3452 | 704.2 | Lower | 0.21 |
| UCD | 1992 | Channel catfish | 1 | 1114 | 386.0 | Upper | 0.38 |
| UCD | Sep-00 | Channel catfish | 1 | 6881 | 750 | Unknown | 0.21 |
| UCD | Sep-00 | Channel catfish | 1 | 9344 | 815 | Unknown | 0.53 |
| UCD | Sep-00 | Channel catfish | 1 | 4863 | 720 | Unknown | 0.55 |
| UCD | Sep-00 | Channel catfish | 1 | 1383 | 430 | Unknown | 0.54 |
| UCD | Sep-00 | Channel catfish | 1 | 3538 | 570 | Unknown | 0.15 |
| UCD | Sep-00 | Channel catfish | 1 | 8142 | 790 | Unknown | 0.24 |
| UCD | Sep-00 | Channel catfish | 1 | 5783 | 670 | Unknown | 0.83 |
| UCD | Sep-00 | Channel catfish | 1 | 3538 | 605 | Unknown | 0.13 |
| UCD | Sep-00 | Channel catfish | 1 | 2517 | 565 | Unknown | 0.62 |
| UCD | Sep-00 | Channel catfish | 1 | 3252 | 385 | Unknown | 0.21 |
| UCD | Sep-00 | Channel catfish | 1 | 3769 | 610 | Unknown | 0.20 |
| UCD | Sep-00 | Channel catfish | 1 | 1996 | 505 | Unknown | 0.46 |
| UCD | Sep-00 | Channel catfish | 1 | 1030 | 395 | Unknown | 0.25 |
| UCD | Sep-00 | Channel catfish | 1 | 2422 | 535 | Unknown | 0.16 |
| UCD | Sep-00 | Channel catfish | 1 | 7779 | 805 | Unknown | 0.37 |
| UCD | Sep-00 | Channel catfish | 1 | 6967 | 760 | Unknown | 0.61 |
| UCD | Sep-00 | Channel catfish | 1 | 5498 | 720 | Unknown | 0.44 |
| UCD | Sep-00 | Channel catfish | 1 | 6069 | 705 | Unknown | 0.76 |
| UCD | Sep-00 | Channel catfish | 1 | 7153 | 755 | Unknown | 0.47 |
| UCD | Sep-00 | Channel catfish | 1 | 9526 | 855 | Unknown | 0.31 |
| UCD | Sep-00 | Channel catfish | 1 | 4740 | 730 | Unknown | 0.55 |
| UCD | Sep-00 | Channel catfish | 1 | 4609 | 740 | Unknown | 0.50 |
| UCD | Sep-00 | Channel catfish | 1 | 4808 | 665 | Unknown | 0.28 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| FDA | Mar-80 | Hitch | 1 | | | | 0.54 |
| FDA | Mar-80 | Hitch | 1 | | | | 0.56 |
| CDFG | Feb-88 | Hitch | 1 | 415 | 290 | Upper | 0.1 |
| CDFG | Feb-88 | Hitch | 1 | 356 | 264 | Upper | 0.19 |
| CDFG | Feb-88 | Hitch | 1 | 418 | 287 | Upper | 0.12 |
| CDFG | Feb-88 | Hitch | 1 | 403 | 272 | Upper | 0.16 |
| CDFG | Feb-88 | Hitch | 1 | 439 | 292 | Upper | 0.21 |
| CDFG | Feb-88 | Hitch | 1 | 349 | 274 | Upper | 0.09 |
| CDFG | Feb-88 | Hitch | 1 | 364 | 277 | Upper | 0.13 |
| CDFG | Feb-88 | Hitch | 1 | 304 | 247 | Upper | 0.21 |
| CDFG | Feb-88 | Hitch | 1 | 345 | 265 | Upper | 0.12 |
| CDFG | Feb-88 | Hitch | 1 | 410 | 280 | Upper | 0.07 |
| CDFG | Feb-88 | Hitch | 1 | 393 | 286 | Upper | 0.18 |
| CDFG | Feb-88 | Hitch | 1 | 369 | 281 | Upper | 0.09 |
| CDFG | Feb-88 | Hitch | 1 | 384 | 272 | Upper | 0.16 |
| CDFG | Feb-88 | Hitch | 1 | 353 | 263 | Upper | 0.09 |
| CDFG | Feb-88 | Hitch | 1 | 380 | 275 | Upper | 0.24 |
| CDFG | Feb-88 | Hitch | 1 | 342 | 265 | Upper | 0.24 |
| CDFG | Feb-88 | Hitch | 1 | 417 | 299 | Upper | 0.23 |
| CDFG | Feb-88 | Hitch | 1 | 345 | 265 | Upper | 0.11 |
| CDFG | Feb-88 | Hitch | 1 | 389 | 274 | Upper | 0.28 |
| CDFG | Feb-88 | Hitch | 1 | 426 | 284 | Upper | 0.12 |
| CDFG | May-88 | Hitch | 1 | 205 | 252 | Oaks | 0.15 |
| UCD | Sep-74 | Largemouth bass | 10 | 0.6-3.3 lb | | | 0.47 |
| UCD | Jan-80 | Largemouth bass | 1 | 846 | 368 | Upper | 0.36 |
| UCD | Jan-80 | Largemouth bass | 1 | 495 | 302 | Upper | 0.32 |
| UCD | Jan-80 | Largemouth bass | 1 | 377 | 300 | Upper | 0.35 |
| UCD | Feb-80 | Largemouth bass | 1 | 443 | 292 | Oaks | 0.79 |
| UCD | Mar-80 | Largemouth bass | 2 | 44 | 144 | Oaks | 0.13 |
| UCD | Mar-80 | Largemouth bass | 1 | 793 | 355 | Oaks | 0.87 |
| UCD | May-80 | Largemouth bass | 2 | 451 | 290 | Upper | 0.54 |
| UCD | Mar-81 | Largemouth bass | 1 | | 304 | Unknown | 0.32 |
| UCD | Mar-81 | Largemouth bass | 1 | | 312 | Unknown | 0.4 |
| UCD | Mar-81 | Largemouth bass | 1 | | | Unknown | 0.51 |
| UCD | Mar-81 | Largemouth bass | 1 | | 357 | Unknown | 0.49 |
| UCD | Mar-81 | Largemouth bass | 1 | | 342 | Unknown | 0.41 |
| UCD | Mar-81 | Largemouth bass | 1 | | 467 | Unknown | 0.74 |
| UCD | Mar-81 | Largemouth bass | 1 | | 490 | Unknown | 0.95 |
| UCD | Mar-81 | Largemouth bass | 1 | | 310 | Unknown | 0.17 |
| UCD | Mar-81 | Largemouth bass | 1 | | 337 | Unknown | 0.18 |
| UCD | Mar-81 | Largemouth bass | 1 | | 489 | Unknown | 1.37 |
| DHS | Mar-81 | Largemouth bass | 1 | | 341 | Unknown | 1.91 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| CDFG | Mar-81 | Largemouth bass | 1 | | 441 | Unknown | 0.58 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 353 | Unknown | 0.27 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 399 | Unknown | 0.54 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 400 | Unknown | 1.01 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 319 | Unknown | 0.26 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 357 | Unknown | 0.35 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 468 | Unknown | 1.52 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 315 | Unknown | 0.29 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 362 | Unknown | 0.54 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 302 | Unknown | 0.55 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 411 | Unknown | 0.68 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 355 | Unknown | 0.89 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 422 | Unknown | 0.53 |
| CDFG | Mar-81 | Largemouth bass | 1 | | 330 | Unknown | 1.03 |
| CDFG | Aug-84 | Largemouth bass | 6 | 368 | 264 | Lower | 0.53 |
| CDFG | Aug-84 | Largemouth bass | 7 | 323 | 256 | Upper | 0.3 |
| CDFG | Aug-84 | Largemouth bass | 5 | 477 | 293 | Oaks | 0.73 |
| CDFG | Aug-85 | Largemouth bass | 1 | 480 | 289 | Oaks | 0.92 |
| CDFG | Aug-86 | Largemouth bass | 1 | 292 | 252 | Oaks | 0.34 |
| CDFG | Aug-86 | Largemouth bass | 1 | 324 | 246 | Oaks | 0.31 |
| CDFG | Aug-86 | Largemouth bass | 1 | 522 | 276 | Oaks | 0.34 |
| CDFG | Aug-86 | Largemouth bass | 1 | 358 | 272 | Oaks | 0.48 |
| CDFG | Aug-86 | Largemouth bass | 1 | 349 | 264 | Oaks | 0.66 |
| CDFG | Aug-86 | Largemouth bass | 1 | 378 | 272 | Oaks | 0.33 |
| CDFG | Aug-86 | Largemouth bass | 1 | 383 | 264 | Oaks | 0.29 |
| CDFG | Aug-87 | Largemouth bass | 1 | 370 | 275 | Lower | 0.37 |
| CDFG | Aug-87 | Largemouth bass | 1 | 474 | 293 | Lower | 0.51 |
| CDFG | Aug-87 | Largemouth bass | 1 | 539 | 310 | Lower | 0.39 |
| CDFG | Aug-87 | Largemouth bass | 1 | 574 | 317 | Lower | 0.42 |
| CDFG | Aug-87 | Largemouth bass | 1 | 1378 | 424 | Lower | 0.81 |
| CDFG | Aug-87 | Largemouth bass | 1 | 1706 | 426 | Lower | 0.92 |
| CDFG | Aug-87 | Largemouth bass | 1 | 83 | 169 | Oaks | 0.18 |
| CDFG | Aug-87 | Largemouth bass | 1 | 98 | 172 | Oaks | 0.22 |
| CDFG | Aug-87 | Largemouth bass | 1 | 103 | 175 | Oaks | 0.33 |
| CDFG | Aug-87 | Largemouth bass | 1 | 109 | 179 | Oaks | 0.5 |
| CDFG | Aug-87 | Largemouth bass | 1 | 114 | 180 | Oaks | 0.36 |
| CDFG | Aug-87 | Largemouth bass | 1 | 113 | 184 | Oaks | 0.47 |
| CDFG | Aug-87 | Largemouth bass | 1 | 116 | 187 | Oaks | 0.25 |
| CDFG | Aug-87 | Largemouth bass | 1 | 140 | 198 | Oaks | 0.62 |
| CDFG | Aug-87 | Largemouth bass | 1 | 134 | 199 | Oaks | 0.37 |
| CDFG | Aug-87 | Largemouth bass | 1 | 155 | 200 | Oaks | 0.41 |
| CDFG | Aug-87 | Largemouth bass | 1 | 168 | 211 | Oaks | 0.45 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| CDFG | Aug-87 | Largemouth bass | 1 | 165 | 218 | Oaks | 0.24 |
| CDFG | Aug-87 | Largemouth bass | 1 | 194 | 221 | Oaks | 0.57 |
| CDFG | Aug-87 | Largemouth bass | 1 | 228 | 225 | Oaks | 0.42 |
| CDFG | Aug-87 | Largemouth bass | 1 | 270 | 232 | Oaks | 0.44 |
| CDFG | Aug-87 | Largemouth bass | 1 | 223 | 235 | Oaks | 0.67 |
| CDFG | Aug-87 | Largemouth bass | 1 | 236 | 238 | Oaks | 0.58 |
| CDFG | Aug-87 | Largemouth bass | 1 | 266 | 240 | Oaks | 0.6 |
| CDFG | Aug-87 | Largemouth bass | 1 | 257 | 242 | Oaks | 0.72 |
| CDFG | Aug-87 | Largemouth bass | 1 | 308 | 242 | Oaks | 0.59 |
| CDFG | Aug-87 | Largemouth bass | 1 | 363 | 262 | Oaks | 0.83 |
| CDFG | Aug-87 | Largemouth bass | 1 | 363 | 284 | Oaks | 0.58 |
| CDFG | Aug-87 | Largemouth bass | 1 | 405 | 287 | Oaks | 0.76 |
| CDFG | Aug-87 | Largemouth bass | 1 | 462 | 290 | Oaks | 0.65 |
| CDFG | Aug-87 | Largemouth bass | 1 | 534 | 296 | Oaks | 0.43 |
| CDFG | Aug-87 | Largemouth bass | 1 | 676 | 321 | Oaks | 0.59 |
| CDFG | Aug-87 | Largemouth bass | 1 | 76 | 162 | Upper | 0.13 |
| CDFG | Aug-87 | Largemouth bass | 1 | 102 | 180 | Upper | 0.12 |
| CDFG | Aug-87 | Largemouth bass | 1 | 130 | 194 | Upper | 0.32 |
| CDFG | Aug-87 | Largemouth bass | 1 | 132 | 204 | Upper | 0.16 |
| CDFG | Aug-87 | Largemouth bass | 1 | 169 | 218 | Upper | 0.2 |
| CDFG | Aug-87 | Largemouth bass | 1 | 153 | 219 | Upper | 0.23 |
| CDFG | Aug-87 | Largemouth bass | 1 | 185 | 225 | Upper | 0.2 |
| CDFG | Aug-87 | Largemouth bass | 1 | 210 | 229 | Upper | 0.28 |
| CDFG | Aug-87 | Largemouth bass | 1 | 230 | 234 | Upper | 0.34 |
| CDFG | Aug-87 | Largemouth bass | 1 | 272 | 251 | Upper | 0.46 |
| CDFG | Aug-87 | Largemouth bass | 1 | 457 | 275 | Upper | 0.38 |
| CDFG | Aug-87 | Largemouth bass | 1 | 363 | 276 | Upper | 0.2 |
| CDFG | Aug-87 | Largemouth bass | 1 | 401 | 279 | Upper | 0.28 |
| CDFG | Aug-87 | Largemouth bass | 1 | 405 | 283 | Upper | 0.36 |
| CDFG | Aug-87 | Largemouth bass | 1 | 410 | 286 | Upper | 0.31 |
| CDFG | Aug-87 | Largemouth bass | 1 | 428 | 292 | Upper | 0.51 |
| CDFG | Aug-87 | Largemouth bass | 1 | 556 | 297 | Upper | 0.32 |
| CDFG | Aug-87 | Largemouth bass | 1 | 403 | 298 | Upper | 0.38 |
| CDFG | Nov-87 | Largemouth bass | 1 | 928 | 370 | Upper | 0.73 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1219 | 402 | Upper | 0.48 |
| CDFG | Nov-87 | Largemouth bass | 1 | 743 | 331 | Upper | 0.43 |
| CDFG | Nov-87 | Largemouth bass | 1 | 908 | 362 | Upper | 0.52 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1385 | 400 | Upper | 0.48 |
| CDFG | Nov-87 | Largemouth bass | 1 | 894 | 354 | Upper | 0.45 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1165 | 385 | Upper | 0.48 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1176 | 399 | Upper | 0.51 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1396 | 397 | Upper | 0.58 |

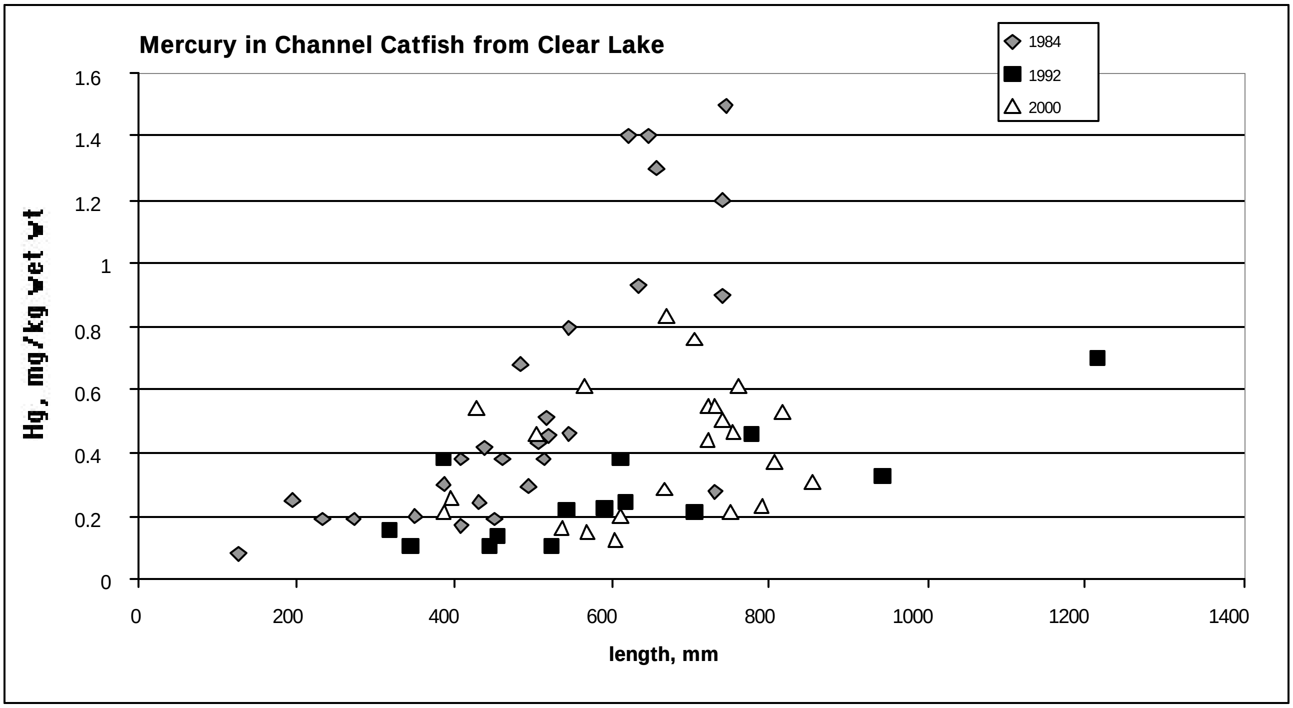
| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| CDFG | Nov-87 | Largemouth bass | 1 | 743 | 348 | Upper | 0.34 |
| CDFG | Nov-87 | Largemouth bass | 1 | 937 | 336 | Upper | 0.45 |
| CDFG | Nov-87 | Largemouth bass | 1 | 639 | 327 | Upper | 0.32 |
| CDFG | Nov-87 | Largemouth bass | 1 | 581 | 332 | Upper | 0.4 |
| CDFG | Nov-87 | Largemouth bass | 1 | 796 | 339 | Upper | 0.3 |
| CDFG | Nov-87 | Largemouth bass | 1 | 852 | 364 | Upper | 0.76 |
| CDFG | Nov-87 | Largemouth bass | 1 | 891 | 365 | Upper | 0.42 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1121 | 375 | Upper | 0.65 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1070 | 398 | Upper | 0.69 |
| CDFG | Nov-87 | Largemouth bass | 1 | 902 | 368 | Upper | 0.45 |
| CDFG | Nov-87 | Largemouth bass | 1 | 2435 | 482 | Upper | 1.03 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1138 | 369 | Oaks | 0.79 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1800 | 430 | Oaks | 0.87 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1264 | 394 | Oaks | 0.79 |
| CDFG | Nov-87 | Largemouth bass | 1 | 811 | 349 | Oaks | 0.66 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1002 | 371 | Oaks | 0.78 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1684 | 428 | Oaks | 1.05 |
| CDFG | Nov-87 | Largemouth bass | 1 | 665 | 348 | Oaks | 0.57 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1309 | 412 | Oaks | 1.84 |
| CDFG | Nov-87 | Largemouth bass | 1 | 638 | 333 | Oaks | 0.41 |
| CDFG | Nov-87 | Largemouth bass | 1 | 753 | 343 | Oaks | 0.75 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1082 | 371 | Oaks | 1.52 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1155 | 385 | Oaks | 0.76 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1347 | 407 | Oaks | 0.74 |
| CDFG | Nov-87 | Largemouth bass | 1 | 926 | 352 | Oaks | 0.52 |
| CDFG | Nov-87 | Largemouth bass | 1 | 782 | 352 | Oaks | 0.72 |
| CDFG | Nov-87 | Largemouth bass | 1 | 2910 | 515 | Oaks | 1.75 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1447 | 432 | Oaks | 0.78 |
| CDFG | Nov-87 | Largemouth bass | 1 | | 431 | Oaks | 0.73 |
| CDFG | Nov-87 | Largemouth bass | 1 | 1270 | 430 | Oaks | 1.69 |
| CDFG | Nov-87 | Largemouth bass | 1 | 2080 | 454 | Oaks | 1.25 |
| CDFG | Dec-87 | Largemouth bass | 1 | 595 | 331 | Lower | 0.34 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1091 | 357 | Lower | 0.28 |
| CDFG | Dec-87 | Largemouth bass | 1 | 821 | 354 | Lower | 0.3 |
| CDFG | Dec-87 | Largemouth bass | 1 | 403 | 289 | Lower | 0.13 |
| CDFG | Dec-87 | Largemouth bass | 1 | 906 | 353 | Lower | 0.22 |
| CDFG | Dec-87 | Largemouth bass | 1 | 919 | 372 | Lower | 0.35 |
| CDFG | Dec-87 | Largemouth bass | 1 | 498 | 294 | Lower | 0.12 |
| CDFG | Dec-87 | Largemouth bass | 1 | 918 | 355 | Lower | 0.46 |
| CDFG | Dec-87 | Largemouth bass | 1 | 774 | 325 | Lower | 0.19 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1997 | 427 | Lower | 0.33 |
| CDFG | Dec-87 | Largemouth bass | 1 | 2095 | 430 | Lower | 0.44 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| CDFG | Dec-87 | Largemouth bass | 1 | 2853 | 469 | Lower | 0.53 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1723 | 410 | Lower | 0.36 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1727 | 437 | Lower | 0.35 |
| CDFG | Dec-87 | Largemouth bass | 1 | 564 | 322 | Lower | 0.5 |
| CDFG | Dec-87 | Largemouth bass | 1 | 961 | 351 | Lower | 0.22 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1785 | 406 | Lower | 0.56 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1274 | 378 | Lower | 0.25 |
| CDFG | Dec-87 | Largemouth bass | 1 | 894 | 353 | Lower | 0.49 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1848 | 430 | Lower | 0.35 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1136 | 382 | Lower | 0.44 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1970 | 432 | Lower | 0.71 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1019 | 349 | Lower | 0.34 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1317 | 372 | Lower | 0.29 |
| CDFG | Dec-87 | Largemouth bass | 1 | 1289 | 403 | Lower | 0.53 |
| CDFG | 1992 | Largemouth bass | 1 | 619 | | Oaks | 0.63 |
| CDFG | 1992 | Largemouth bass | 3 | 966 | | Oaks | 0.5 |
| CDFG | 1992 | Largemouth bass | 3 | 1362 | | Oaks | 0.73 |
| CDFG | 1992 | Largemouth bass | 2 | 2274 | | Oaks | 0.91 |
| CDFG | 1992 | Largemouth bass | 1 | 2913 | | Oaks | 0.66 |
| CDFG | 1992 | Largemouth bass | 4 | 1078 | | Oaks | 0.8 |
| CDFG | 1992 | Largemouth bass | 2 | 342 | | Oaks | 0.29 |
| CDFG | 1992 | Largemouth bass | 2 | 839 | | Oaks | 0.77 |
| CDFG | 1992 | Largemouth bass | 1 | 1358 | | Oaks | 0.44 |
| CDFG | 1992 | Largemouth bass | 1 | 398 | | Lower | 0.13 |
| CDFG | 1992 | Largemouth bass | 2 | 832 | | Lower | 0.1 |
| CDFG | 1992 | Largemouth bass | 2 | 1752 | | Lower | 0.39 |
| CDFG | 1992 | Largemouth bass | 2 | 2106 | | Lower | 0.58 |
| CDFG | 1992 | Largemouth bass | 3 | 473 | | Upper | 0.27 |
| CDFG | 1992 | Largemouth bass | 1 | 862 | | Upper | 0.37 |
| CDFG | 1992 | Largemouth bass | 5 | 1871 | | Upper | 0.75 |
| CDFG | 1992 | Largemouth bass | 1 | 2709 | | Upper | 0.77 |
| CDFG | 1992 | Largemouth bass | 2 | 4443 | | Upper | 1.05 |
| CDFG | Mar-80 | Mississippi Silverside | 4 | 3 | 81 | Oaks | 0.02 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| UCD | 1992 | Sacramento blackfish | 1 | 1187 | | Oaks | 0.46 |
| UCD | 1992 | Sacramento blackfish | 1 | 1322 | | Lower | 0.45 |
| CDFG | Feb-80 | Sacramento blackfish | 1 | 589 | 359 | Oaks | 0.3 |
| CDFG | Feb-80 | Sacramento blackfish | 1 | 564 | 345 | Oaks | 0.38 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 936 | 393 | Upper | 0.3 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 888 | 371 | Upper | 0.18 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 1022 | 398 | Upper | 0.32 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 827 | 399 | Upper | 0.35 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 854 | 370 | Upper | 0.29 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 881 | 372 | Upper | 0.18 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 1002 | 389 | Upper | 0.27 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 706 | 335 | Upper | 0.24 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 781 | 362 | Upper | 0.27 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 965 | 371 | Upper | 0.17 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 895 | 384 | Upper | 0.19 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 1186 | 400 | Upper | 0.38 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 1009 | 377 | Upper | 0.18 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 879 | 369 | Upper | 0.45 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | | 398 | Upper | 0.2 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 860 | 355 | Upper | 0.26 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 780 | 368 | Upper | 0.29 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 1125 | 383 | Upper | 0.39 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 766 | 340 | Upper | 0.26 |
| CDFG | Feb-88 | Sacramento blackfish | 1 | 889 | 347 | Upper | 0.08 |
| UCD | 1992 | White catfish | 1 | 65 | | Lower | 0.1 |
| DHS | Sep-74 | White catfish | 10 | 0.4-1 lb | | | 0.26 |
| CDFG | Feb-80 | White catfish | 1 | 377 | 305 | Oaks | 0.52 |
| CDFG | Feb-80 | White catfish | 1 | 123 | 209 | Oaks | 0.24 |
| CDFG | Mar-80 | White catfish | 3 | 357 | 278 | Oaks | 0.24 |
| CDFG | Apr-80 | White catfish | 3 | 272 | 280 | Oaks | 0.24 |
| CDFG | May-80 | White catfish | 2 | 291 | 270 | Upper | 0.33 |
| CDFG | May-80 | White catfish | 1 | 191 | 230 | Upper | 0.21 |
| CDFG | Aug-84 | White catfish | 6 | 467 | 305 | Lower | 0.29 |
| CDFG | Aug-84 | White catfish | 6 | 439 | 301 | Oaks | 0.21 |
| CDFG | Aug-87 | White catfish | 1 | 356 | 287 | Lower | 0.26 |
| CDFG | Aug-87 | White catfish | 1 | 309 | 280 | Oaks | 0.63 |
| CDFG | Aug-87 | White catfish | 1 | 321 | 281 | Oaks | 0.6 |
| CDFG | Aug-87 | White catfish | 1 | 424 | 296 | Oaks | 0.86 |
| CDFG | Aug-87 | White catfish | 1 | 461 | 309 | Upper | 0.64 |
| CDFG | Aug-87 | White catfish | 1 | 472 | 321 | Upper | 0.75 |
| CDFG | Aug-87 | White catfish | 1 | 544 | 325 | Upper | 0.85 |
| CDFG | Aug-87 | White catfish | 1 | 691 | 337 | Upper | 0.78 |

| Table A-3 continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Agency Collecting Sample | Date | Species | Number of fish in sample | Weight (gms) | Length (mm) | Location | Hg, mg/kg wet weight edible tissue |
| CDFG | Aug-87 | White catfish | 1 | 914 | 359 | Upper | 0.58 |
| CDFG | Feb-88 | White catfish | 1 | 693 | 316 | Upper | 0.67 |
| CDFG | Feb-88 | White catfish | 1 | 439 | 291 | Upper | 0.37 |
| CDFG | Feb-88 | White catfish | 1 | 869 | 332 | Upper | 0.54 |
| CDFG | Jun-88 | White catfish | 1 | 225 | 248 | Oaks | 0.62 |
| CDFG | Jun-88 | White catfish | 1 | 211 | 230 | Oaks | 0.43 |
| CDFG | Jun-88 | White catfish | 1 | 274 | 265 | Oaks | 0.56 |
| CDFG | Jun-88 | White catfish | 1 | 248 | 248 | Oaks | 0.56 |
| CDFG | Jun-88 | White catfish | 1 | 215 | 243 | Oaks | 0.42 |
| CDFG | Jun-88 | White catfish | 1 | 360 | 271 | Oaks | 0.6 |
| CDFG | Jun-88 | White catfish | 1 | 395 | 292 | Oaks | 0.36 |
| CDFG | Jun-88 | White catfish | 1 | 329 | 283 | Oaks | 0.4 |
| CDFG | Jun-88 | White catfish | 1 | 549 | 317 | Oaks | 0.52 |
| CDFG | Jun-88 | White catfish | 1 | 575 | 340 | Oaks | 0.61 |
| CDFG | Jun-88 | White catfish | 1 | 861 | 371 | Oaks | 0.37 |
| CDFG | Jun-88 | White catfish | 1 | 619 | 328 | Oaks | 0.35 |
| CDFG | Jun-88 | White catfish | 1 | 562 | 327 | Oaks | 0.47 |
| CDFG | Jun-88 | White catfish | 1 | 959 | 383 | Oaks | 0.46 |
| CDFG | Feb-88 | White crappie | 1 | 489 | 278 | Upper | 0.42 |
| CDFG | May-88 | White crappie | 1 | 196 | 229 | Oaks | 0.39 |
| CDFG | Jun-88 | White crappie | 1 | 400 | 304 | Oaks | 1.3 |
| CDFG | Jun-88 | White crappie | 1 | 281 | 252 | Oaks | 0.18 |
| CDFG | Jun-88 | White crappie | 1 | 197 | 238 | Oaks | 0.15 |
| CDFG | Jun-88 | White crappie | 1 | 208 | 240 | Oaks | 0.92 |
| CDFG | Jun-88 | White crappie | 1 | 190 | 240 | Oaks | 0.44 |
| CDFG | Jun-88 | White crappie | 1 | 226 | 249 | Oaks | 0.27 |
| CDFG | Jun-88 | White crappie | 1 | 202 | 238 | Oaks | 0.36 |
| CDFG | Jun-88 | White crappie | 1 | 229 | 245 | Oaks | 0.32 |

Figure A-1.



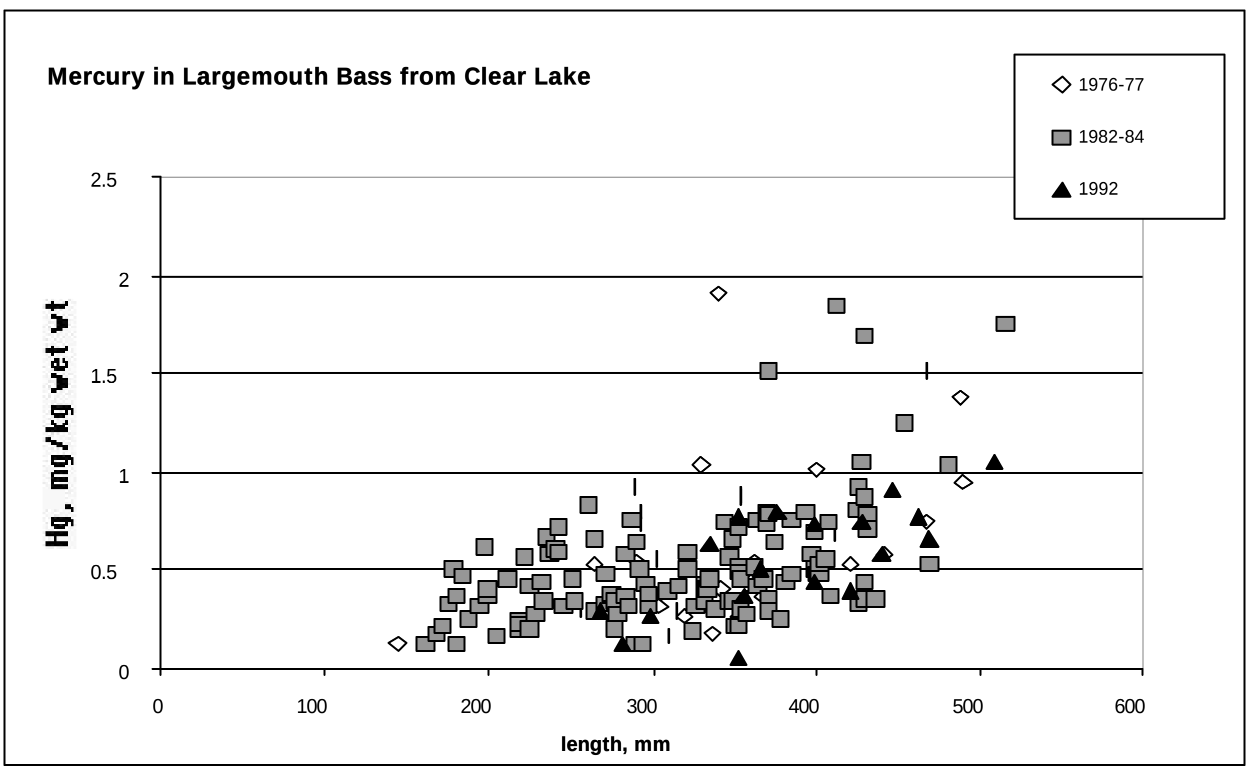




Figure A-2.

## APPENDIX B. SEDIMENT CONCENTRATIONS IN CLEAR LAKE

Table B-1 contains raw data for mercury and methylmercury in sediment from Clear Lake. The sampling sites are shown in Figure 1. Data were provided by the UC Davis Clear Lake Environmental Research Center. These sediment data were used to determine existing conditions described in the proposed Basin Plan amendment (Section 2 of this report) and to develop the proposed sediment compliance goals.

Sediment concentrations of total mercury in Upper and Lower Arms varied little during previous sampling years (Suchanek et al., 1997). Therefore, some samples were only analyzed for methylmercury to reduce sampling costs. Additional data on the sites with relatively consistent levels of total mercury are available in previous reports from UC Davis (Suchanek et al., 1993; Suchanek et al., 1997). Surficial sediment concentrations of mercury from deep sediment core samples collected in 1996 and 2000 were also used to determine the existing sediment concentrations (See Appendix D of the *Clear Lake TMDL for Mercury Final Report*).

Table B-1. Mercury and Methylmercury in Clear Lake Sediment, 1996-1998

| Date sampled | Location | Methylmercury Concentration, ng/g | Total Mercury Concentration, µg/g |
|---|---|---|---|
| May-97 | Lower Arm 04 | 2.51 | |
| May-97 | Lower Arm 04 | 1.69 | |
| May-97 | Lower Arm 04 | 3.32 | 2.79 |
| May-97 | Lower Arm 04 | 2.92 | |
| May-97 | Lower Arm 06 | 1.08 | 0.553 |
| | | | |
| May-96 | Narrows 01 | 1.47 | |
| Aug-96 | Narrows 01 | 2.68 | |
| Oct-96 | Narrows 01 | 3.89 | |
| Nov-96 | Narrows 01 | 5.98 | |
| Feb-97 | Narrows 01 | 2.16 | |
| May-97 | Narrows 01 | 0.64 | |
| May-97 | Narrows 01 | 0.18 | |
| Aug-97 | Narrows 01 | 3.40 | 11.6 |
| Aug-97 | Narrows 01 | 2.46 | |
| Mar-98 | Narrows 01 | 1.64 | 9.23 |
| | | | |
| Jun-96 | North Wetlands | 30.7 | 5.59 |
| Jun-96 | North Wetlands | 12.1 | 2.11 |
| Jun-96 | North Wetlands | 52.0 | 2.71 |
| Jun-96 | North Wetlands | 15.0 | 1.75 |
| Oct-96 | North Wetlands | 5.36 | 4.87 |
| Oct-96 | North Wetlands | 3.51 | 4.00 |
| Oct-96 | North Wetlands | 1.0 | 7.12 |
| | | | |

Table B-1. Mercury and Methylmercury in Clear Lake Sediment, 1996-1998

| Date sampled | Location | Methylmercury Concentration, ng/g | Total Mercury Concentration, µg/g |
|---|---|---|---|
| May-96 | Oaks Arm 01 | 7.19 | 191 |
| Aug-96 | Oaks Arm 01 | 4.75 | 244 |
| Aug-96 | Oaks Arm 01 | 5.04 | 195 |
| Aug-96 | Oaks Arm 01 | 7.70 | 203 |
| Oct-96 | Oaks Arm 01 | 7.70 | 184 |
| Oct-96 | Oaks Arm 01 | 6.29 | 212 |
| Oct-96 | Oaks Arm 01 | 5.45 | 200 |
| Nov-96 | Oaks Arm 01 | 11.0 | 187 |
| Nov-96 | Oaks Arm 01 | 12.6 | 165 |
| Nov-96 | Oaks Arm 01 | 9.31 | 214 |
| Feb-97 | Oaks Arm 01 | 8.37 | 217 |
| Feb-97 | Oaks Arm 01 | 8.30 | 163 |
| Feb-97 | Oaks Arm 01 | 8.79 | 210 |
| May-97 | Oaks Arm 01 | 14.5 | 217 |
| May-97 | Oaks Arm 01 | 15.6 | |
| Aug-97 | Oaks Arm 01 | 11.6 | 231 |
| Aug-97 | Oaks Arm 01 | 10.0 | 258 |
| Aug-97 | Oaks Arm 01 | 9.91 | 239 |
| Mar-98 | Oaks Arm 01 | 25.0 | 177 |
| Mar-98 | Oaks Arm 01 | 22.1 | 195 |
| Mar-98 | Oaks Arm 01 | 36.4 | 156 |
| | | | |
| May-96 | Oaks Arm 04 | 4.01 | |
| Aug-96 | Oaks Arm 04 | 4.93 | |
| Oct-96 | Oaks Arm 04 | 4.14 | |
| Nov-96 | Oaks Arm 04 | 8.89 | |
| Feb-97 | Oaks Arm 04 | 3.10 | |
| May-97 | Oaks Arm 04 | 2.45 | |
| May-97 | Oaks Arm 04 | 2.16 | |
| Aug-97 | Oaks Arm 04 | 4.21 | 35.3 |
| Aug-97 | Oaks Arm 04 | 3.59 | |
| Mar-98 | Oaks Arm 04 | 3.70 | 31.4 |

| Table B-1 continued | | | |
|---|---|---|---|
| Date sampled | Location | Methylmercury Concentration, ng/g | Total Mercury Concentration, $\mu$g/g |
| Aug-96 | Oaks Arm Floc site | 19.4 | 14.9 |
| Oct-96 | Oaks Arm Floc site | 4.56 | 8.6 |
| Nov-96 | Oaks Arm Floc site | 9.33 | 16.5 |
| Feb-97 | Oaks Arm Floc site | 18.3 | 20.7 |
| Feb-97 | Oaks Arm Floc site | 1.14 | 6.56 |
| Feb-97 | Oaks Arm Floc site | 8.13 | 50.5 |
| May-97 | Oaks Arm Floc site | 102 | |
| May-97 | Oaks Arm Floc site | 23.5 | |
| Aug-97 | Oaks Arm Floc site | 11.6 | 31.5 |
| Aug-97 | Oaks Arm Floc site | 13.9 | |
| Mar-98 | Oaks Arm Floc site | 10.0 | 119 |
| Apr-98 | Oaks Arm Floc site | 20.4 | 417 |
| Apr-98 | Oaks Arm Floc site | 7.75 | 255 |
| Apr-98 | Oaks Arm Floc site | 10.00 | 293 |
| Jun-98 | Oaks Arm Floc site | 7.94 | 224 |
| Jun-98 | Oaks Arm Floc site | 15.0 | 204 |
| Jun-98 | Oaks Arm Floc site | 12.0 | 358 |
| Jul-98 | Oaks Arm Floc site | 6.58 | 162 |
| Jul-98 | Oaks Arm Floc site | 11.0 | 150 |
| Aug-98 | Oaks Arm Floc site | 58.6 | 64.4 |
| Sep-98 | Oaks Arm Floc site | 16.3 | 172 |
| Oct-98 | Oaks Arm Floc site | 10.4 | 63.6 |
| Jan-99 | Oaks Arm Floc site | 7.48 | 258 |
| | | | |
| May-96 | Upper Arm 01 | 1.23 | |
| Aug-96 | Upper Arm 01 | 2.82 | |
| Aug-96 | Upper Arm 01 | 2.90 | |
| Oct-96 | Upper Arm 01 | 3.63 | |
| Oct-96 | Upper Arm 01 | 2.25 | |
| Nov-96 | Upper Arm 01 | 4.84 | |
| Nov-96 | Upper Arm 01 | 4.24 | |
| Feb-97 | Upper Arm 01 | 1.49 | |
| Feb-97 | Upper Arm 01 | 1.46 | |
| May-97 | Upper Arm 01 | | 3.74 |
| Aug-97 | Upper Arm 01 | 2.84 | 3.63 |
| Mar-98 | Upper Arm 01 | 0.962 | 2.94 |

| Table B-1 continued | | | |
|---|---|---|---|
| Date sampled | Location | Methylmercury Concentration, ng/g | Total Mercury Concentration, µg/g |
| May-96 | Upper Arm 04 | 1.70 | |
| Aug-96 | Upper Arm 04 | 2.23 | |
| Oct-96 | Upper Arm 04 | 1.65 | |
| Nov-96 | Upper Arm 04 | 3.14 | |
| Feb-97 | Upper Arm 04 | 1.57 | |
| May-97 | Upper Arm 04 | 1.19 | |
| May-97 | Upper Arm 04 | 0.861 | |
| Aug-97 | Upper Arm 04 | 2.05 | 1.82 |
| Aug-97 | Upper Arm 04 | 1.74 | |
| Mar-98 | Upper Arm 04 | 1.05 | 2.12 |
| Aug-97 | Upper Arm 06 | 0.852 | 0.0017 |

## APPENDIX C. CALCULATION OF NUMERIC WATER QUALITY OBJECTIVES

### Alternative 2. Adoption of USEPA's Recommended Water Quality Criterion for Methylmercury (0.3 mg/kg, wet weight)

The following equation was used for calculation of USEPA's recommended fish-tissue based methylmercury water quality criterion (USEPA, 2001b):

$$\frac{(\text{RfD} - \text{intake from other sources}) * \text{body weight}}{(CR_{TL2*} + CR_{TL3} + CR_{TL4})} = \text{Acceptable level of mercury in fish}$$

Where: RfD = reference dose for humans, representing the safe, total daily intake of methylmercury (0.1 micrograms/kg body weight per day).

Intake from other sources = average intake of methylmercury from marine fish by adults in the general population, as reported in the USDA 1994-96 nationally based Continuing Survey of Food Intake for Individuals (CSFII). The average intake from marine fish is 0.027 micrograms/kg bodyweight per day. (USEPA, 2000b). Other sources of methylmercury such as drinking water, provide negligible quantities (USEPA, 2001b).

CRTL2 = consumption rate of fish from Trophic Level 2 (3.8 g/day)

CRTL3 = consumption rate of fish from Trophic Level 3 (8.0 g/day)

CRTL4 = consumption rate of fish from Trophic Level 4 (5.7 g/day)

The total of these consumption rates, 17.5 g/day, is the 90th percentile consumption rate reported in the USDA 1994-96 CFSII. This was a nationwide survey of the general population of the United States. Consumption rate data include people who do not eat fish or shellfish (USEPA, 2000b).

Application of USEPA's reference dose and default consumption rates to the above equation:

$$\frac{(0.10\ \mu g/kg\ day - 0.027\ \mu g/kg\ day) * 70\ kg}{(3.8\ g/day + 8.0\ g/day + 5.7\ g/day)} = 0.3\ \mu g\ \text{methylmercury/g fish tissue}$$

(Note: 0.3 µg/g fish tissue is equivalent to 0.3 mg/kg or 0.3 ppm.)

### Equations for Calculation of Alternatives 3-5

The initial USEPA methylmercury criteria report did not describe how the criterion should be applied to fish species with different concentrations of methylmercury. (A USEPA guidance document is expected to be released in 2003.) A logical way to interpret the USEPA criterion is to assume that the criterion of 0.3 mg/kg is an average concentration of methylmercury in locally caught fish, weighted by the proportions of fish from each trophic level or species consumed. Creel survey data collected by the California Department of Fish and Game indicates that of the fish caught and kept from Clear Lake, more are from trophic level 4 and fewer from trophic levels 2 and 3 than indicated in the national survey data (Macedo, 1991; Cannata, 2000). To adapt the USEPA criterion using Clear Lake-specific data, Regional Board staff assumed that fish caught and kept are also consumed.

Organizing fish species and consumption rates by trophic level of the fish is useful for determining safe fish tissue concentrations for humans and wildlife (USEPA 2000b; USEPA 1997). By rearranging Equation 1, the estimated daily intake of methylmercury from a given set of fish tissue concentrations and consumption rates can be determined. Then, by comparing estimated daily intakes with the acceptable daily intake of methylmercury, acceptable tissue concentrations in each trophic level can be identified. This approach was used for calculation of objectives in Alternatives 3-5. This method allows for easy comparisons of reductions needed to protect humans versus various wildlife species. The variables needed to use this equation for determining fish tissue concentrations protective of humans and wildlife are given below.

Alternatives 3-5 were calculated in three steps:

Equation 2: estimate current intake of methylmercury from eating locally caught fish

Equation 3: determine the percent reduction in intake needed so that current intake equals the safe intake of methylmercury

Equation 4: apply the percent reduction needed in methylmercury intake to existing fish tissue concentrations to determine the target concentration in fish tissue.

*Equation 2* (rearrangement of Equation 1):

$$\frac{(FTL2*CRTL2)+(FTL3*CRTL3)+(FTL4*CRTL4)}{\text{body weight}} = \text{estimated daily intake of methylmercury}$$

Where: $F_{TL2}$ = methylmercury concentration in fish of trophic level 2
$F_{TL3}$ = methylmercury concentration in fish of trophic level 3
$F_{TL4}$ = methylmercury concentration in fish of trophic level 4

*Equation 3*

$$\frac{\text{Estimated intake} - \text{safe daily intake}}{\text{Estimated intake}} = \text{reduction needed in the estimated daily intake}$$

Where: safe daily intake = reference dose minus intake from sources other than local fish.
(Multiplication by 100 gives the reduction needed expressed as a percentage.)

*Equation 4*

The reduction needed in daily intake of methylmercury is proportionally the same as the reduction needed in fish tissue concentrations. The acceptable fish tissue concentration of methylmercury is the water quality objective.

$$\text{Existing fish tissue concentration} * (1 - \text{reduction in daily intake}) = \text{acceptable concentration of methylmercury in fish}$$

**Data and Variables for Calculation of Alternatives 3-5**

To use Equation 2 to calculate safe fish tissue concentrations in each trophic level for humans and wildllife, the same basic variables are needed as used in Equation 1. These are: consumption rates, average body weights, and reference doses. To compare existing intakes with the reference doses, existing concentrations of methylmercury in Clear Lake fish are also needed. The following paragraphs and tables present the variables used for calculation of Alternatives 3-5.

*Fish tissue concentrations*
Existing concentrations of methylmercury in Clear Lake trophic levels are shown in Table C-1. For each trophic level, the concentration presented is the average of fish sampled within that trophic level. The species and size ranges of the fish sampled are also indicated. Creel surveys indicate that humans catch fish over a broad size range. Therefore, all fish tissue data available was used to calculate average concentrations of mercury in fish consumed by humans. Wildlife species tend to consume fish within a more narrow size range. For estimating wildlife intakes of methylmercury, average fish tissue concentrations in fish of likely prey size were used. Typical prey sizes from published literature (not specific to Clear Lake) are shown in Table C-3. Individual fish tissue data, from which the averages were calculated, are shown in Appendix A.

Table C-1. Average Concentrations of Mercury in Clear Lake Fish

| **Calculation** | **Fish species and size range (total length)** | **Average fish tissue concentration, mg/kg** |
|---|---|---|
| Trophic Level 4 for calculation of human health risk (a) | Largemouth bass (> 310 mm)<br>Channel catfish (> 250 mm)<br>White catfish (> 250 mm)<br>Black crappie (> 200 mm)<br>White crappie (> 200 mm)<br>Brown bullhead (> 250 mm) | 0.50 |
| Trophic Level 4 for calculation of wildlife health risk (b) | Largemouth bass (175-450 mm)<br>Channel catfish (250-450 mm)<br>White catfish (250-450 mm)<br>Black crappie (200-450 mm)<br>White crappie (200-450 mm)<br>Brown bullhead (250-450 mm) | 0.45 |
| Trophic Level 3 for calculation of human health risk | Bluegill<br>Carp<br>Hitch<br>Sacramento blackfish<br>Catfish (< 250 mm)<br>Crappie (< 200 mm) | 0.22 |
| Trophic Level 3 for calculation of wildlife health risk | Bluegill<br>Carp<br>Hitch<br>Sacramento blackfish<br>Catfish and bullhead (< 250 mm)<br>White and black crappie (< 200 mm)<br>Largemouth bass (< 175 mm)<br>Inland silverside | 0.15 |

Table C-1. Average Concentrations of Mercury in Clear Lake Fish

| | Fish species and size range (total length) | Average fish tissue concentration, mg/kg |
|---|---|---|
| Trophic Level 2-3 for calculation of risk for kingfisher and other small pisciverous wildlife. | Inland silverside (<110 mm)<br>Juvenile largemouth bass (<110 mm) | 0.10 |

(a) Although largemouth bass less than 300mm length are likely feeding at trophic level 4, the legal size limit for largemouth bass in Clear Lake is 12 inches (310 mm). Therefore, for calculation of human risk, only data for bass larger than 310 mm were included.

(b) Bald eagle frequently eat fish larger than 450 mm in length (USEPA, 1995, Trophic Level and Exposure Analyses for Selected Piscivorous Birds and Mammals, Vol. II: Analyses of Species in the Conterminus United States. Office of Water, Washington DC.) Therefore, for calculation of estimated daily intake for bald eagle, staff used the same average fish tissue concentration in TL4 fish as was used for estimating human intake.

*Fish Consumption Rates - Human*

Creel survey data show that the ratio of trophic level 4 to trophic level 3 fish caught and kept in Clear Lake is approximately 70/30 (Macedo, 1991; Cannata, 2000). The diet of a typical consumer of Clear Lake fish, then, was assumed to contain 70% of fish from trophic level 4 and 30% from trophic level 3. No trophic level 2 species was reported as being caught for consumption. To produce possible objectives that were more specific to Clear Lake conditions, this proportion of trophic level 4 to 3 fish was applied to two rates representing total consumption of Clear Lake fish.

Table C-2. Human Consumption Rates for Alternative Water Quality Objectives

| Alternative | Total Consumption Rate of Locally Caught Fish (g/day) | Trophic Level 3 Consumption Rate (30% of total; g/day) | Trophic Level 4 Consumption Rate (70% of total; g/day) |
|---|---|---|---|
| 3 | 17.5 (a) | 5.2 | 12.3 |
| 4 | 30 (b) | 9 | 21 |

(a) USEPA's default consumption rate for the general population and for recreational fishers (USEPA, 2000b).

(b) Consumption rate reported by the 90th percentile of participants in a small study of mercury exposure and effects at Clear Lake. Study participants were 64 members of the Elem Tribe and 4 non-tribal neighbors (Harnly et al., 1997).

Alternative 5 uses a consumption rate of 907 g/day of trophic level 3 fish. Representatives of the Elem Tribe indicate that adult members of the Elem Tribe traditionally ate approximately two pounds of fish from Clear Lake per day, mainly hitch (Personal communication, Michael Umbrello, Elem Tribe). This traditional consumption rate is an estimate and may be adjusted as more information is gathered from Tribal elders. The resources of Clear Lake have been utilized by present-day Elem and their ancestors for over 11,800 years. Prior to the introduction of sport fish, such as channel catfish and largemouth bass to Clear Lake, trophic level 3 species were dominant in the lake (CDFG, 1998).

*Body Weights and Reference Doses - Human*

Site-specific objectives for protection of human health incorporated a slightly different body weight of 65 kg, than that used in the USEPA criterion. The body weight used is the standard for a pregnant female. This body weight was selected to acknowledge the particular sensitivity of unborn children to toxic effects of methylmercury.

These objectives also used the same reference dose of 0.1 µg methylmercury/kg body weight per day and assumed the same intake of methylmercury from sources other than locally caught fish, 0.027 µg methylmercury/kg body weight per day.

*Consumption Rates and Body Weights – Wildlife*

Wildlife species most likely at risk for mercury toxicity are primarily or exclusively piscivorous. Table C-3 lists species potentially at risk along with their body weights and consumption rates. Authors of the Mercury Study Report to Congress (MRSC) selected two mammals and four bird species of concern in habitat across the country. All of these species occur regularly at Clear Lake. The following species of concern for Clear Lake have been added to the basic list from the MRC: western grebe, common merganser, great blue heron and double crested cormorant. Otter, raptors and loon eat larger fish, on average, than the other wildlife mentioned. Kingfishers eat fish in the smallest size range.

Table C-3 Exposure Parameters for Fish-eating Wildlife

| Fish-eating Species | Approximate Size of Fish Consumed (mm) | Estimated Fish Ingestion Rate TL3 (g fish/day, wet wt) | Estimated Fish Ingestion Rate TL4 (g fish/day, wet wt) | Average Body Weight (kg) |
|---|---|---|---|---|
| River otter | 300 - 450 | 976 | 244 | 7.4 |
| Mink | 50 - 200 | 160 | 0 | 0.8 |
| Bald eagle (a) | 75 – 500+ | 370 | 90 | 4.6 |
| Osprey (b) | 75 - 450 | 270 | 30 | 1.5 |
| Loon | 200 - 400 | 800 | 0 | 4 |
| Common merganser (c) | < 350 | 302 | 0 | 1.23 |
| Double-crested cormorant | 100 - 250 | 310 | 0 | 1.7 |
| Western grebe (c) | < 350 | 374 | 0 | 1.48 |
| Great blue heron juveniles (d) | < 100 | 245 | 0 | 1.0 |
| Kingfisher (e) | 40 -105 | 75 | 0 | 0.15 |

Exposure parameters are from the USEPA Exposure Factors Handbook (USEPA, 1993b) and the Mercury Study Report to Congress, Vol. 7 (USEPA, 1997d). Additional information for particular species is given in footnotes. Fish size and ingestion estimates also provided by U.S. Fish and Wildlife Service (Haas, 2001; Schwarzbach, 2001. Values from the reports listed below vary slightly from the Handbook due to: rounding of numbers; selection of values for males, females or both; or slight differences in conversion of dry weight diet measurements to wet weight. For comparison, an average two-pound channel catfish from Clear Lake is 320 mm (just over 12 inches) long.

(a) Bald eagle were evaluated for the Great Lakes Water Quality Initiative (USEPA, 1995d). Eight percent, or 40 g/day of the bald eagle's diet is not aquatic (USEPA, 1995d). USFWS estimates that most non-aquatic prey of bald eagles at Clear Lake would be piscivorous birds or mammals, which provide an additional source of methylmercury. Bald eagles are scavengers, and thus could eat fish from a wide size range.

(b) In lakes with robust sport fish populations and large ex panses of relatively shallow depths, "it is not uncommon for osprey to catch and consume significant amounts of TL4 fish. In such waterbodies, it would be appropriate to assume a diet composition of 90% TL3 fish and 10% TL4 fish. (USFWS, 2002)

(c) Exposure parameters provided by S. Schwarzbach, U.S. Fish and Wildlife Service (2001). Mergansers are known to take fish up to 350 mm length, but prey size is limited by fish girth.

(d) Prey species based on field observations at Clear Lake (Wolfe and Norman, 1998).

(e) Fish longer than 105 mm in length are difficult for kingfishers to swallow (Hamas, 1994).

*Reference Doses – Wildlife*

Following the risk assessment methods used in the Great Lakes Water Quality Initiative (GLWQI) and the MRSC, an acceptable daily intake level determined for mink is assumed to be appropriate for other mammalian wildlife species. Using the mink feeding studies by Wobeser, MSRC authors determined a reference dose for mammalian wildlife of 0.018 mg/kg bwt/day (Wobeser, 1976; USEPA, 1997). Likewise, an acceptable daily intake level determined for mallard ducks is used for all birds. Mallard reproduction studies by Heinz et al. (Heinz, 1974; Heinz, 1976a; Heinz, 1976b; Heinz, 1979) were used to determine an avian reference dose of 0.021 mg/kg bwt/day (USEPA, 1997).

**Alternative 3. Adoption of Site-Specific Objectives Based on a Consumption Rate by Humans of 17.5 grams/day of Locally-Caught Fish (0.3 mg/kg, wet weight for trophic level 4 fish; 0.13 mg/kg wet wt for trophic level 3 fish)**

Application of Equation 2, using fish tissue concentrations shown in Table A-1, total consumption rate of Clear Lake fish of 17.5 g/day, and body weight of 70 kg to determine estimated daily intake of methylmercury under existing conditions:

*Alternative 3 - Application of Equation 2:*

$$\frac{(0\ \text{g/day}*0.18\ \mu\text{g/g})+(5.3\ \text{g/day}*0.22\ \mu\text{g/g})+(12.3\ \text{g/day}*0.5\ \mu\text{g/g})}{65\ \text{kg bwt}} = 0.112\ \mu\text{g/kg bwt-day}$$

The estimated intake is then compared with the safe daily intake (reference dose minus intake from other sources) to determine reduction needed in existing intakes of methylmercury.

*Alternative 3 - Application of Equation 3:*

$$\frac{(0.112\ \mu\text{g/kg bwt day} - 0.073\ \mu\text{g/kg bwt day})}{0.112\ \mu\text{g/kg bwt day}} = 0.35$$

*Alternative 3 - Application of Equation 4:*
In order to safely consume 17.5 g/day, current fish tissue concentrations must be reduced 35% (or must be 65% of current levels). To achieve an intake that is below the acceptable daily intake level for local fish, reduce current levels by 40% (goal is 60% of current levels).

**For trophic level 4:**
0.50 mg/kg * (1 – 0.40) = **0.30 mg methylmercury/kg fish tissue)**

**For trophic level 3:**
0.22 mg/kg * (1 – 0.40) = **0.13 mg methylmercury/kg fish tissue)**

**Alternative 4. Adoption of Site-Specific Objectives Designed to Protect Humans and Endangered Species**

Estimated daily intakes of methylmercury were determined for piscivorous wildlife species and compared with mammalian wildlife and avian reference doses. These calculations were performed exactly as shown in the application of Equations 2, 3 and 4 for Alternative 3, using wildlife parameters shown in Tables C–3 and C-4. Example calculations are shown below for the osprey. Parameters used and results for other wildlife species are shown in Table C-4. For additional information, see the Clear Lake Mercury Numeric Target Report and comments by USFWS regarding the report (USFWS, 2002).

*Osprey - Application of Equation 2:*
For osprey feeding in a shallow, open waterbody such as Clear Lake, a significant portion of their diet likely consists of large fish (USFWS, 2002). To account for eating larger fish, the concentration of mercury in larger, trophic level 3 fish generally consumed by humans was used (0.22 mg/kg), instead of

the trophic level 3 concentration used to calculate intake by most other wildlife species (0.15 mg/kg). Existing methylmercury concentrations in Clear Lake fish eaten by wildlife are given in Table C-4. The estimated intake of methylmercury by osprey feeding at Clear Lake is 48.6 mg/kg per day.

$$\frac{(0.22 \text{ mg/g} * 270 \text{ g/day}) + (0.45 \text{ mg/g} * 30 \text{ g/day})}{1.5 \text{ kg}} = 48.6\ \mu\text{g methylmercury/kg bwt day}$$

*Osprey – Application of Equation 3:*
The estimated intake is then compared with the safe daily intake to determine reduction needed in existing intakes of methylmercury. For wildlife species, intake of methylmercury is assumed to be from locally caught fish (unlike humans, wildlife are not eating commercial fish). Drinking water intakes are negligible (USEPA, 1997d). Therefore, the safe daily intake for wildlife species is the same as the reference dose.

$$\frac{(48.6\ \mu\text{g/kg bwt day} - 21\ \mu\text{g/kg bwt day})}{48.6\ \mu\text{g/kg bwt day}} = 0.57$$

*Osprey - Application of Equation 4:*
In order for osprey to safely consume Clear Lake fish, current fish tissue concentrations must be reduced 57% (or must be 43% of current levels). USFWS staff did not advise adding an extra safety factor.

**For trophic level 4**
0.45 mg/kg * (1 – 0.57) = 0.19 mg methylmercury/kg fish tissue

**For trophic level 3:**
0.22 mg/kg * (1 – 0.57) = 0.09 mg methylmercury/kg fish tissue

Calculations of estimated daily intakes and percent reduction of methylmercury in fish tissue needed to protect other wildlife species are shown in Table C-4. The reductions in methylmercury concentrations needed by osprey, bald eagle, and river otter are very similar.

Table C-4. Calculation of Clear Lake Wildlife Objectives

| Species | Estimated consumption, g/day wet wt | | | | Body weight, kg | Existing concentrations of mercury in Clear Lake fish, ■g/g wet wt | | | | Estimated daily intake; (=consumption rate times fish level divided by body wt) | Reference dose (Source: USEPA 1997d) | Ratio of RfD to exposure | % Reduction from current levels needed to meet safe intake |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TL 2-3 | TL-3 | TL 4 | Fish-eating bird | | TL 2-3 | TL 3 | TL 4 | Fish-eating bird | µg/kg bwt day | µg/kg bwt day | | |
| river otter | 976 | | 244 | | 7.4 | 0.15 | 0.22 | 0.45 | | 35 | 18 | 0.52 | 48 |
| river otter * | | 976 | 244 | | 7.4 | 0.15 | 0.22 | 0.45 | | 44 | 18 | 0.41 | 59 |
| bald eagle * | 0 | 370 | 90 | 28 | 4.6 | 0.15 | 0.22 | 0.50 | 3.00 | 46 | 21 | 0.46 | 54 |
| mink | 160 | | 0 | | 0.8 | 0.15 | 0.22 | 0.45 | | 30 | 18 | 0.60 | 40 |
| osprey * | | 270 | 30 | | 1.5 | 0.15 | 0.22 | 0.45 | | 49 | 21 | 0.43 | 57 |
| common loon | 800 | | 0 | | 4 | 0.15 | 0.22 | 0.45 | | 30 | 21 | 0.70 | 30 |
| common merganser | 302 | | 0 | | 1.23 | 0.15 | 0.22 | 0.45 | | 37 | 21 | 0.57 | 43 |
| double crested cormorant | 310 | | 0 | | 1.7 | 0.15 | 0.22 | 0.45 | | 27 | 21 | 0.77 | 23 |
| western grebe | 344 | | 0 | | 1.48 | 0.15 | 0.22 | 0.45 | | 35 | 21 | 0.60 | 40 |
| juvenile great blue heron | 245 | | 0 | | 1.0 | 0.15 | 0.22 | 0.45 | | 37 | 21 | 0.57 | 43 |
| kingfisher ** | 75 | | 0 | | 0.15 | 0.10 | 0.22 | 0.45 | | 50 | 21 | 0.42 | 58 |
| **Wildlife objectives for Clear Lake: 57% reduction** (average of the percent reductions for kingfisher, bald eagle, osprey and otter eating larger fish, which are all above 50%). | | | | | | | | | | | | | |
| river otter | 976 | | 244 | | 7.4 | 0.06 | 0.09 | 0.19 | | 15 | 18 | 1.21 | -20.9 |
| river otter * | | 976 | 244 | | 7.4 | 0.06 | 0.09 | 0.19 | | 19 | 18 | 0.95 | 5 |
| bald eagle * | 0 | 370 | 90 | 28 | 4.6 | 0.06 | 0.09 | 0.22 | 1.29 | 20 | 21 | 1.07 | -6.8 |
| mink | 160 | | 0 | | 0.8 | 0.06 | 0.09 | 0.19 | | 13 | 18 | 1.40 | -39.5 |
| osprey * | | 270 | 30 | | 1.5 | 0.06 | 0.09 | 0.19 | | 21 | 21 | 1.00 | |
| loon | 800 | | 0 | | 4 | 0.06 | 0.09 | 0.19 | | 13 | 21 | 1.63 | -62.8 |
| merganser | 302 | | 0 | | 1.23 | 0.06 | 0.09 | 0.19 | | 16 | 21 | 1.33 | -32.6 |
| cormorant | 310 | | 0 | | 1.7 | 0.06 | 0.09 | 0.19 | | 12 | 21 | 1.79 | -78.5 |
| western grebe | 344 | | 0 | | 1.48 | 0.06 | 0.09 | 0.19 | | 15 | 21 | 1.40 | -40.1 |
| juvenile great blue heron | 245 | | 0 | | 1.0 | 0.06 | 0.09 | 0.19 | | 16 | 21 | 1.33 | -32.9 |
| kingfisher | 75 | | 0 | | 0.15 | 0.04 | 0.09 | 0.19 | | 22 | 21 | 0.98 | 2.3 |

*** Bald Eagle**. Concentration in piscivorous birds is the average concentration in grebes collected at Clear Lake (CDFG, 1984).

*** River Otter**. The USFWS comments do not provide specific calculations for river otter. However, USFWS points out that in the Mercury Study Report to Congress, river otter prey is classified as TL3, not TL2-3. It is nearly impossible to knowwhat otter prey ranges are for particular waterbodies. USFWS points out it is entirely possible that river otter at Clear Lake eat less TL2 and more TL4 fish than reported in the scientific literature. Two possibilities are therefore included for otter intake, based on TL2-3 and all TL3 prey species. Given a 57% reduction, the otter is essentially protected (estimated intake 19 µg/kg/day vs. 18 µg/kg/day reference dose).

**Alternative 5. Adoption of Site-Specific Objectives Based on a Subsistence Consumption Rate**

An alternative for a Clear Lake-specific objectives was developed using a consumption rate of 907 g/day. When traditional fish harvesting practices were followed, Native Americans at Clear Lake reportedly ate approximately two pounds of fish from Clear Lake per day, mainly hitch (Personal communication with Tribal representatives, 29 May 2002). Two pounds per day is equivalent to 907 g/day. In order for local residents to safely consume 907 g/day of hitch, existing levels of methylmercury in hitch must be reduced by approximately 97%. Hitch is a trophic level 3 species. Because the objective is based on traditional fishing practices, it was assumed that all fish consumed were from TL3 species from Clear Lake. Therefore, the estimated intake is compared directly to the reference dose. The native assemblage of Clear Lake fish was heavily dominated by TL3 species. To obtain objectives for the current-day TL4 fish, the same percent reduction was applied.

*Alternative 5 - Application of Equation 2:*

$$\frac{(907 \text{ g/day} * 0.22\ \mu\text{g/g}) + (0 \text{ g/day} * 0.5\ \mu\text{g/g})}{65 \text{ kg bwt}} = 3.07\ \mu\text{g/kg bwt-day}$$

*Alternative 5 - Application of Equation 3:*

$$\frac{(3.07\ \mu\text{g/kg bwt day} - 0.1\ \mu\text{g/kg bwt day})}{3.07\ \mu\text{g/kg bwt day}} = 0.97$$ (97% reduction needed in existing concentrations in TL3 fish)

*Alternative 5 - Application of Equation 4:*

In order to safely consume 907 g/day of trophic level current fish tissue concentrations must be reduced 97%.

**For trophic level 4:**

0.50 mg/kg * (1 – 0.97) = 0.02 mg methylmercury/kg fish tissue)

**For trophic level 3:**

0.22 mg/kg * (1 – 0.40) = 0.007 mg methylmercury/kg fish tissue)

## APPENDIX D. PRE-MINING CONCENTRATIONS IN CLEAR LAKE SEDIMENTS

Deep sediment cores collected by multiple institutions provide a fairly clear, consistent picture of sediment concentrations of mercury in the pre-mining period. Data used to determine average background sediment concentrations at various points in the lake are described below. The background concentrations were used to determine the sediment compliance goals shown in Table D-1.

Sediment compliance goals were determined for sites at which cores have been collected and background and surface concentrations are known, and at additional sites in Oaks Arm. Sediment background concentrations were determined at the core sites by taking the average of concentrations in core segments dated prior to the opening of Sulphur Bank Mercury Mine. (Because the Humboldt State cores were not dated, average background was calculated for core segments prior to the sharp increase in mercury concentrations seen in dated and undated cores.) Those averages are shown in Table D-2.

Table D-1. Pre-mining Mercury Concentrations in Clear Lake Sediments from Deep Core Samples

| Core | Distance to SBMM, (km) | Background Concentration (mg/kg) |
|---|---|---|
| HSU 8 | 1.4 | 9.3 |
| UCD OA03A 2000 | 1.8 | 9.4 |
| UCD OA03C 2000 | 1.8 | 8.7 |
| UCD OA03 1996 | 1.8 | 15 |
| HSU 5.0 | 2.3 | 4.8 |
| USGS 6 | 3.5 | 4.3 |
| HSU 10 | 4.0 | 5.3 |
| HSU 4.1 | 4.5 | 8.3 |
| HSU 1.1 | 4.7 | 3.8 |
| HSU 11 | 5.1 | 3.3 |
| HSU 12 | 8.7 | 0.8 |
| UCD LA03 * | 12 | 0.8 |
| UCD UA03 * | 18 | 0.3 |

Sources:
HSU - cores collected by Humboldt State University (Chamberlin et al., 1990).
UCD - cores collected by UC Davis Clear Lake Environmental Research Center, 1996 and 2000; (Suchanek et al., 1997; Clear Lake TMDL report)
USGS - Sims and White, 1981
* Distances from SBMM to the Lower and Upper Arm site are given as absolute distances; distance of water travel between the sites is likely different.

Concentrations in Table D-2 were plotted against distance from the mine in Figure D-1. Background concentrations for the Oaks Arm sites lacking core data were determined using the equation of the best-fit line in the plot. The sediment compliance sites for which background concentrations were estimated are: OA-01, OA-02, OA-04, and NR-01. Sediment compliance sites and background sediment concentrations are shown in Table D-2. The geothermal spring at SBMM was a natural source of mercury, so it is logical that background mercury concentrations would decrease with distance away from the spring.

Figure D-1

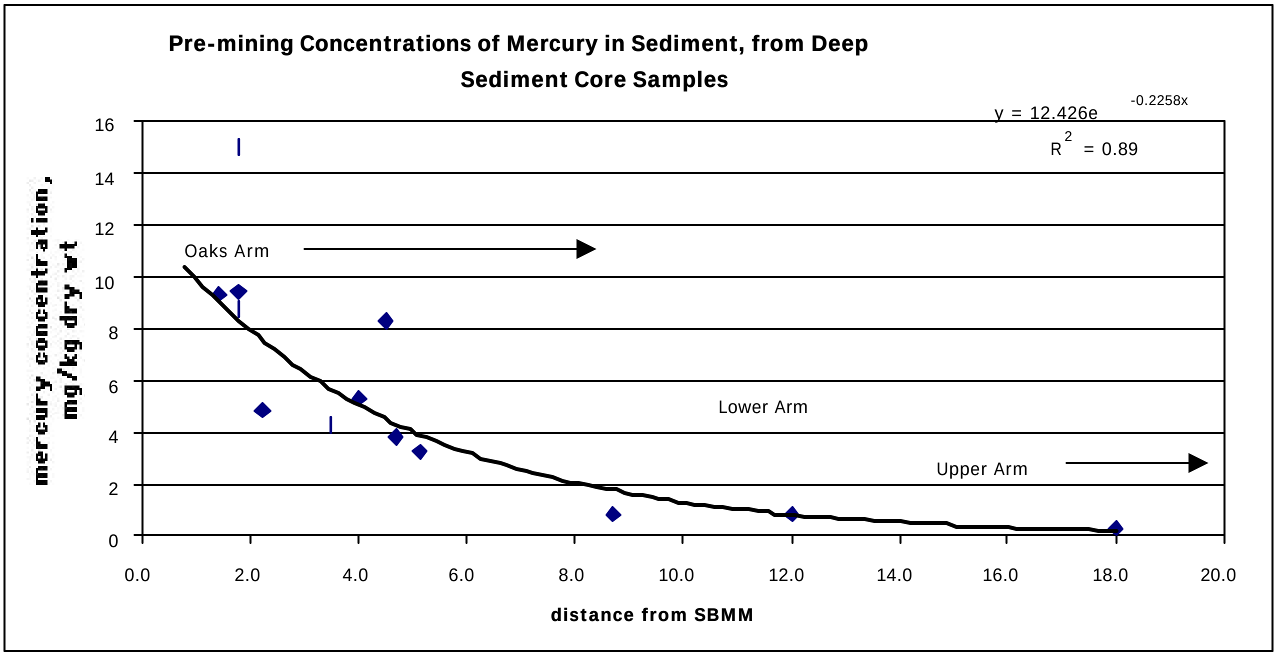



Table D-2. Premining Concentrations of Mercury at Sediment Compliance Sites

| Sediment Compliance Site | Distance from SBMM (km) | Surficial Sediment, 1996-2000 (mg/kg dry wt) | Pre-mining Concentration ("background") (mg/kg dry wt) |
|---|---|---|---|
| OA-01 | 0.3 | 208.75 | 12.0 |
| OA-02 | 0.8 | 92 | 10.0 |
| OA-03 | 1.8 | 53 | 8.0 |
| OA-04 | 3 | 33.83 | 6.3 |
| NR-01 | 7.7 | 10.4 | 2.2 |
| LA-03 | 12 | 3.6 | 0.8 |
| UA-03 | 18 | 2.8 | 0.3 |

## APPENDIX E. CLEAR LAKE TMDL FOR MERCURY FINAL REPORT

The Clear Lake Mercury TMDL is available on the Central Valley Regional Water Board's web site: http://www.swrcb.ca.gov/rwqcb5/programs/tmdl/clearlake.htm.

The TMDL report has not been revised to include the information presented in this Basin Plan staff report.

# APPENDIX F. RECOMMENDED FORMAT FOR COMMENT LETTERS

Comment letters to the Regional Board on this staff report serve two purposes: (1) to point out areas of agreement with staff recommendations; and (2) to suggest revisions to staff recommendations. The California Environmental Quality Act requires staff to respond to those comments submitted by the public that suggest revisions to staff recommendations, so long as those comments concern revisions to the Basin Plan amendment. The use of the following format for comment letters will help Regional Board staff easily identify suggested revisions and accurately respond to the specific concerns of the commenter. Please contact Patrick Morris at (916)255-3121 if you have any questions regarding the proposed Basin Plan amendment.

**Format for Comments Suggesting Revisions**

Regional Board staff suggest that commenters do the following: (a) number each comment, (b) state in one sentence the topic upon which the comment is focused, (c) provide a supporting argument, and (d) make a recommendation. Supporting arguments that include citations will help staff evaluate the comment.

***Example:*** The Environmental Action Team (EAT) recommends the following revision to Regional Water Board staff recommendations:

*1. Proposed Xenon objective for Slug Slough.*

Staff has recommended a 0.001 ng/L Xenon objective to protect resident guppies in Slug Slough. The USEPA Xenon criteria for protection of guppies in fresh waters is currently 0.0001 ng/L – an order of magnitude lower than the staff recommendation. USEPA criteria is supported by several studies in peer reviewed journals (e.g., Smith and Jones; J. Env. Qual. (1994); Johnson; J. Env. Qual. (1995)). Staff arguments that the cost of analyzing for Xenon in water below 0.001 ng/L is prohibitive does not support the adoption of a water quality criterion that is not protective of beneficial uses. More cost effective analytical procedures may be developed in response to the need for more intensive Xenon analysis. EAT, therefore, strongly recommends the adoption of a 0.0001 ng/L Xenon objective to fully protect guppies in Slug Slough.

**Format for Comments Supporting Staff Recommendations**

If the commenter concurs with a staff recommendation, a statement to that effect will help the Regional Board determine what action, if any, to take on the staff recommendation. No supporting discussion needs be presented unless the commenter feels that the staff recommendation could be enhanced or clarified.

***Example:***

*1. Proposed Neon Objective for Slug Slough*

EAT strongly supports the adoption of the 0.05 pg/L Neon objective proposed by staff for Slug Slough. In addition to arguments presented by staff, it should be pointed out that Harrison's recent work on goldfish (Harrison, et al., 1996; see "References") confirms the appropriateness of the proposed objective for the protection of fresh water aquatic life.